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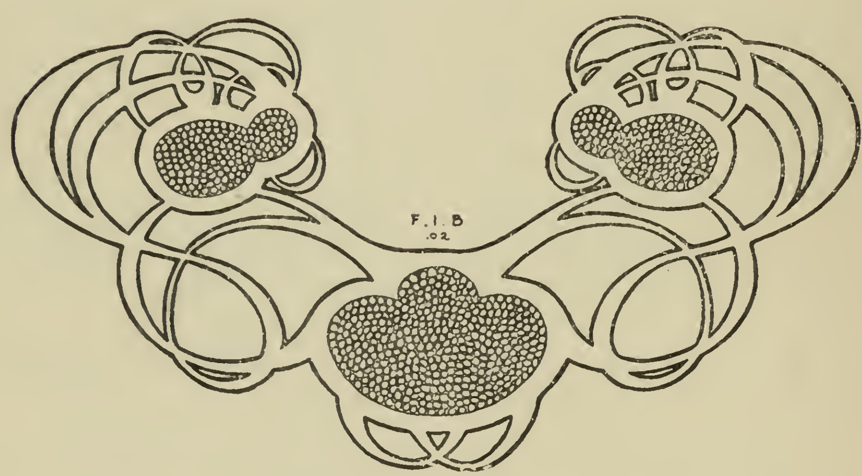

THE ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

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THE WORKING OF A LABOR DEPARTMENT IN INDUSTRIAL ESTABLISHMENTS.

By C. U. Carpenter.

Widespread and serious labor troubles, recent and current, and on both sides of the Atlantic, point out the critical importance of Mr. Carpenter's theme. It needs no more than the report of the "Coal-Strike Commission" to establish the truth of his central proposition—*"the time to stop trouble is before it begins."* And the need of definite, organized attention to putting this principle into practice exists in every works which has grown beyond the point where the manager can be in personal touch with every workman. The means for doing this successfully must be more complex in a large establishment, but the conception is universally applicable. Further reference to the matter is made in our Editorial Comment on page 99.—THE EDITORS.

THE "Labor Problem" now confronting us cannot be solved until the same principles of organization that have been such great factors in commercial success are brought to bear upon it. Manufacturers generally, though they have recognized the seriousness of the situation for some time, are just beginning to realize the necessity for a general and comprehensive plan of organization. Practical experience has already proven the great value of strongly organized bodies of employers to meet and bargain with the existing organizations of labor. Experience also shows that these organizations of labor will themselves be benefitted ultimately by the existence of such a bodies of employers.

It is my purpose not to dwell upon the value of such organizations, but to bring out the great benefits to be derived by applying the general ideas of organization and specialization to this subject in the case of the individual manufacturer.

Whether employer and employee be organized in mutual bodies or not, one of the greatest needs of the present day is the development of some plan that will bring about a closer personal relation between them. To the loss of this "personal relation" and feeling of mutuality of interest can be attributed most of the trouble of the present day. In this day of huge corporations the employers are entirely out of touch with their workmen. That this works untold harm cannot be doubted. Most employers are fair-minded and would be willing to grant to their employees justice in regard to any complaints that they may have. The majority of them are willing that their workmen shall earn as large a wage as the conditions surrounding their business justify them in paying. The tendency amongst most of them is toward the providing of better working conditions for their employees. These facts are, however, seldom recognized by the workmen. Nor does it seem possible to cultivate any better feeling on the part of the employee toward his employer unless some attempt is made to restore the old-time "personal touch" between the two that to this day exists in the small shop. Trouble seldom comes upon the small shop, owing to the fact that difficulties are usually met and settled by the employer himself before they can grow into an unwarranted importance. Why not adopt a plan in the case of the large corporation that will ensure that all difficulties shall be met in the same manner?

"The time to stop trouble is before it begins."—Some plan of organization must be adopted to make this possible. Some method should exist whereby employer and men could get together and discuss their mutual difficulties before trouble begins. For when once trouble does arise, and it has become so acute as to require the attention of the employer, he may be certain that by that time the feelings and prejudices of all who have attempted to handle the proposition have been aroused to a high pitch. There is certain to be a large degree of bad feeling and doubt of good intention on the part of both parties to the controversy.

Many times the workmen's proposal is too absurd for the employer to entertain for a moment. The workmen, on the other hand, often embittered by delays and lack of consideration on the part of their immediate superiors, at times insist upon its acceptance. Or, on the other hand, the employer upon considering the case, will often see in the proposal a large element of justice which he would have admitted without hesitation if the proposition had come to him "first-handed."

He however often feels obliged to refuse such proposals for the sake of discipline and his desire to stand by his subordinates. Many bitter strikes have occurred under such conditions—strikes which could have been easily avoided had the questions been met *fairly, firmly*, and *promptly*. Whether or not the proposals are fair, in either case most desirable results can be accomplished by giving them prompt attention together with just and firm consideration at the time when they are first presented.

Consider the actual questions that give rise to strikes, lockouts and, following these, arbitration and conciliation committees. Consider the gist of the questions that these important bodies must investigate after the trouble has reached the point where, for the sake of the manufacturer, the workman, or the public, they must be called upon. Are not they the practical and fundamental questions of wages, hours, conditions under which men work, discharges, unreasonable demands, unjustifiable and unreasonable rules and practices, restrictions upon employment, limitation of output, etc.? Should we not begin at the lower end of the problem and provide some adequate means whereby the manufacturer and his men can come face to face and consider these questions and problems, fairly and squarely, before the matters get to such a serious issue as to render it necessary to call in outsiders to make a settlement? And settlements so made are rarely wholly acceptable to either party to the dispute, and when finally accepted, leave behind a bitter feeling of resentment.

Both logic and practical experience show the necessity for developing some plan of organization to meet such conditions.

No better introduction to the discussion of the work of the labor department in large industrial organizations can be given than a quotation from Mr. Hermann Justi's address on "Arbitration" delivered at Minneapolis some months ago:

> "Organization of the Employer Class.—All talk of arbitration or anything akin to it is well-nigh idle unless we take account of organization—not only as applied to employees, but organization as applied to employers. Whether we oppose it or favor it, organized labor has come to stay, and it must therefore be considered because we must deal with it. The employer class must organize to a point of excellence and efficiency where organized labor will respect it.
>
> "I am convinced that only by organization can common labor get the maximum wages for its hire. I am equally well convinced that only through organization of the employer class will capital obtain from organized labor the most and the best service in return for the wages paid.
>
> "*It is my belief that all great departments of industry must have their departments of labor, if serious friction is to be avoided and wisely ad-*

> *justed. When we pause to reflect, is it not remarkable that all the departments of great business enterprises have their especially appointed heads to direct and to manage them, with the exception of the department of labor?* This is allowed to get along as best it can, and yet what department of any great business enterprise is of equal importance? This seems the more inexplicable and indefensible in view of the fact that when we reduce the whole problem of business competition to the concrete form, there are only two propositions after all with which the business man has to deal—the price of labor, and the rate of interest."

And are not these absolute facts? What work requires more specialization, more continuous and tactful attention, than the handling of the labor question? And yet upon whom does this delicate and difficult problem actually fall? Is it handled by a department composed of men specially fitted for this question by their education, broad study of labor, and knowledge of labor conditions all over the country? Men selected for their fair-mindedness and practical experience in handling large bodies of men, and of such character as to gain the confidence of the workmen? Men of experience in making labor contracts, who know where the rights of labor end and the transgressions of the rights of capital begin even according to the union constitution?

No! this is seldom the case. The active, actual, everyday working policy of handling labor, the part that is vital to the working man and the manufacturer, is dictated *not by him but by his foreman.*

The superintendent is usually so loaded down with duties and responsibilities that it is almost impossible for him to give this subject the close attention it deserves. Again, he is often in the same condition as the higher officials. He is seldom in close touch with the workers. The foremen who are superintending the departments are exercising the direct and consequently the real potential influence over the men for good or bad. No matter what the manufacturer may desire to do for his men, no matter what his actual policy may be, their feeling toward the firm is governed more by their feeling toward the man who has them in daily control than by any other factors. If this man is weak, the workmen will impose upon him and the company. If harsh, unjust, or inclined to "play favorites," they will be discontented. The foreman will either augment or annul the effect of any good action or purpose of the employer.

These considerations but still further emphasize the necessity for special departments, whose work may be developed along lines similar to those given herewith, and whose functions may be such as actual experience proves necessary.

Work of a Labor Department.—This department should be in control of the labor question with full authority to settle all questions that the men and foremen cannot settle. There should always exist the right of appeal to this department on the part of either workmen or foremen. It sould be its constant aim to settle all questions before they reach an acute stage and assume an unwarranted importance. The questions should be considered directly with the employees affected, no outside influence being permitted to enter. The department should also investigate those practices on the part of the workmen which are unjust to the firm and endeavor to have them corrected. In actual experience great good has been accomplished by investigating and taking up with the workmen such matters as restriction of output, opposition to improved machinery, unjust wage demands, unreasonably high wage rates, unreasonable opposition to justifiable discharges, etc. Many important matters bearing directly upon economy of production, efficiency of workmen, and discipline of the shop have been amicably settled, that would probably have ultimately resulted in serious trouble had they been handled through the usual course in the customary manner.

Such is the nature of the work that a standing advisory committee should be formed, composed of men who are highest in authority in the company, before whom shall be brought all important matters of labor policy and any very serious affairs that cannot be satisfactorily settled. This advisory board should be called together by the labor department on emergencies, and also for monthly reports, these reports to indicate clearly the nature of the troubles settled and progress made.

This work should not be undertaken in a spirit of hostility to the workman. It should be carried out along the lines of justice to all concerned, coupled with firmness in demanding and insisting that that which is right should be granted, and that which is wrong should not be tolerated.

Thorough investigation, prompt action, just decisions, and a firm stand for that which is right should mark the work of such a department.

Wage Question.—The importance of a just and scientific wage system, both from the standpoint of satisfying the workmen and of producing work with the greatest economy, can hardly be over-estimated. The lack of attention to this matter causes much of the trouble between employees and employer. Where it is possible, the supervision of the wage system, together with the power to advise the adjustment of inequalities in wages, should be committed to the care of this department.

This department can with great profit watch for undue shrinkage in output or any tendency toward its limitation. A study of the reason for such conditions, and the changing of the conditions themselves, are often vital to the success of the business.

Increasing the Efficiency of the Factory Force.—The important questions of "employment" and "improving the personnel of the factory force" have a most important connection with efficient production. That the efficiency of the factory force can be largely increased by scientific methods is a fact not generally recognized. In this connection, systematic steps to separate the poor workmen from the efficient for their education and improvement, or, in case they prove totally inefficient, their discharge, are important factors in improving a factory's efficiency. In a properly systematized factory it is not difficult to obtain very accurate information concerning the character, ability, and earning capacity of the different workmen, even though they number thousands. Such data are also valuable in checking up the discharges of the workmen, as any discharge for an unjust cause can be noted at once. The data for all of this work are usually found necessary for the proper use of a wage system. A full consideration of this part of the subject would require an entire article, hence it is not possible to elaborate upon it at this time.

Improvements in Working Conditions.—This department should investigate and have installed such improvements in sanitary and working conditions as experience has shown to be practical. The importance of such work when carried out along practical lines is becoming more and more apparent. It is thoroughly justified on the grounds both of humanity and of economy of production.

Study of Legal Decisions.—An acquaintance with legal decisions bearing upon the rights of capital as well as of labor is often very important. The study of associations of labor and capital and a knowledge of the conditions of both throughout the world are necessary.

Foremen's Meetings.—The work of such a department will be largely ineffective unless it has the support and co-operation of the foremen or men who are in direct charge of departments. These men should be brought into sympathy with its aims and purposes. Generally the responsibility for this labor question is something that they will gladly relinquish, but the seeming interference with their preconceived ideas of the boundaries of their own authority, which its work must involve, will be at first resented. Nothing, however, need or should be done to interfere with the necessary authority of a foreman.

These men must be instructed and trained in the best methods of handling men; most effective ways of increasing their working efficiency, in a manner not detrimental to their health; of increasing their interest in their work, and, especially in union shops, the most effective methods of securing the best results for the company and the men under union conditions.

Certain it is that this department must be so conducted as to deserve and win the confidence of the workmen and foremen in its fairness and firmness. Its decisions must be along the lines of honesty and justice for both company and men, and unless the foremen will give their support to this policy much of the effect of its good work will be lost.

In order to gain the desired results, weekly meetings should be held of all the foremen and assistants for the purpose of discussing the problems and difficulties that they meet every day and of finding some solution.

Where union conditions exist unionism should be discussed, frankly and fairly, in all its phases. The difficulties experienced in regard to it and methods of overcoming their troubles; the best methods of handling men and getting good work from them; methods of encouraging workmen to take more interest in their work; *methods of encouraging all workmen to attend their union meetings and to take an active part in the proceedings; encouraging good workmen to act as officers and members of union committees.* In many cases in my experience when unions were recognized by a company, foremen were found making it so unpleasant for union shop committeemen that only the worst and most radical men would serve; the better men not only would not serve on committees but would not even attend meetings, not caring to be identified with the movement, especially in view of the foremen's attitude. As a direct consequence of this policy the union leaders were invariably of the type that would continually stir up strife and trouble, and would insist, even to the point of strikes, upon the granting of the most unreasonable demands. The conservative men, bound by their obligations and by the company's acceptance of unionism, would be compelled to follow the lead of these men whenever trouble arose. In such cases a policy of encouraging the men to attend their meetings and serving on their committees will result in great good. It should always be kept in mind that these committees are not only the representatives of the men before the company, but also practically the representatives of the company before the unions.

The aims of such a method of education should be:

First.—The instilling into the minds of the foremen the general policy of the firm upon labor matters. A foreman should not be permitted to adopt his own policy and enforce his own rules in regard to such matters, but should be forced to follow the lines laid down by the company and compelled to work in harmony with its general policy and so aid in the development of one harmonious plan.

Second.—The foremen should, through their discussions, get better ideas as regards the proper methods of handling men.

Third.—They should, if wisely guided, learn many things that would result in direct economies in their departments.

Fourth.—Such meetings should develop a most desirable *esprit de corps* amongst the foremen themselves.

Personnel of Labor Department.—It is evident that the men responsible for such work must be chosen with great care. Though representing the employers' interests, they must be careful to carry out the work in such a manner as to deserve and gain the confidence of at least the more conservative elements in the body of workmen. In this plan the introduction of any of the employees as members of the department is not contemplated or even suggested.

More will depend upon the ability, character and experience of the man at the head of such work, than upon any other factors.

He should have had a wide experience in the handling of large bodies of men, both union and non-union. He should have an acquaintance with the heads of existing manufacturer's associations and prominent labor leaders, as well as a thorough knowledge of union methods. He should be thoroughly informed on modern factory systems and methods, especially as applied to wage systems. Mechanical experience is very desirable. Inasmuch as many of the disputes that will arise will concern the question of wages and output, he should be able to devise methods of ascertaining the output that could be fairly expected from any job. He should be capable of introducing methods of increasing the interest of the workmen in their tasks. Such work requires a combination of tact, good judgment, experience in handling men, and executive ability and fairness. In short the man guiding such a department, formed to undertake such work as a safeguard to the company's interest, should possess no small degree of ability. No work is more worthy of the close attention of those high in authority in the company. It is indissolubly linked with the highest and most important interests of the employer. The commercial success of any business depends upon the securing and developing of markets, the development of the economic possibilities of the factory, and the existence and continuance of satisfactory relations between employer and employee.

As can be seen, the work of a labor department, properly developed and carried out, is vitally concerned with the last two factors mentioned.

Such methods have been carried out by the labor department in a large corporation for over a year. It was originally organized by Mr. John H. Patterson, president of the National Cash Register Company, and has been developed along the lines laid down in this article.

This particular company employs almost four thousand men. It is thoroughly unionized, there being represented in the factory eleven international union organizations, twenty-four local unions, and thirty-six shop committees. The policy outlined has had its vindication through the change in the attitude of the workmen. The men now limit their complaints to those which are fair. They deal directly with the company through its labor department, many questions being settled before they are brought up in union meetings.

Representative workmen are chosen for the officers and committees. Very little outside influence is brought to bear upon matters that pertain to the shop. Most of their former illiberal practices are done away with. The tendency is constantly toward a more conservative policy. The practical results attained in this case have more than justified the assertion made of the needs and value of such systematic work directed by a well organized department.

Whether or not a factory is unionized, it is certainly advisable to make a careful and unbiased investigation of actual conditions and ascertain what causes for dissatisfaction exist between the workmen and the management. See that opportunity is given the men to earn a wage such as the business can afford to pay under such a system of pay as is both economical and just. Provide them with sanitary conditions which modern industrial science has demonstrated it pays the employer to give them, and which humanitarian principles dictate as just and fair. Try to establish relations of confidence between yourselves and your employees and provide some means whereby you and they can meet on common ground, so that each can learn of those things that are unfair in the attitude or conduct of the other, and consider these in the spirit of justice. Hear their complaints, correct promptly all evils, insist that they do their share, and that they too correct the evils that they are responsible for, and the desired result will in time be attained. This does not by any means imply a weak policy of handling the question. It is the policy of strength.

PRACTICAL ECONOMY IN THE POWER PLANT.

By W. H. Booth.

Mr. Booth's chief proposition is an enforcement of that stated elsewhere in this issue by Mr. Kimball—that the successful engineer must take full account of the commercial factors in the problems he is called upon to solve. The maximum of efficiency is not of necessity to be found in the closest approach to a certain formula or thermodynamic equation, but in the largest useful return for the input of money and work. It is only when "theory" ignores some of the necessary conditions that it can ever appear to be at variance with "practice." And deductions thus postulated on incomplete or inexact premises are not "theoretical" but "hypothetical." When "all the conditions there are" are recognised, the theoretical and the practical are seen to be, as they needs must always be, identical.—The Editors.

THE end and aim of the engineer is primarily to reach his purpose without unnecessary expense. It is therefore requisite for him to be possessed in the first place of a sufficiency of technical knowledge to enable him to grasp the scientific and technical points on which economy must be based. It is comparatively an easy matter to secure economy of this order; but in doing so the engineer will come into more or less unpleasant contact with other objects of more or less fixity of purpose, and will find that even in seeking a primary economy there are so many difficulties in the way that the economy often melts away.

Let the apparently simple question of fuel combustion be taken as an illustration. An engineer coming fresh upon the field of steam engineering would find steam production carried out on lines that he would perhaps conclude were sound and good. In seeking economy along these lines, he would speedily find that certain furnaces could not do their duty without smoke production. Others, again, could work smokelessly, but at less economy than if allowed to produce smoke. In seeking after perfection, he would find himself confronted with the necessity of using Welsh coal at heavy cost in some furnaces, and an excessive amount of air in others. If, being of a more commercial turn of mind, he tried to use the cheaper coal, he would finally succumb to the difficulties of the position, throw æstheticism to the dogs, and pour out huge volumes of smoke. He would then have solved the problem of commercial economy so far as his apparatus allowed him. He might rest contented at this, did not his filth production bring him into contact with the Smoke Prevention Act. Unless he was in charge of a steam plant so large that the economy of the smoke-producing coal was greater than the expense of fines, he would find that finality had still not been attained, and he might spend weary years on the usual practice of trying quack remedies and nostrums so as to prevent the formation of smoke in improperly constructed furnaces.

Did he, however, possess a sufficiently sound knowledge of the principles of combustion, he might study the question more deeply and find that the existing furnaces owed their forms entirely to a desire to secure a primary economy. The furnace arrangements of almost every boiler sold are based on a minimum first cost. This is the outcome of competition. No maker of boilers dares to advocate the placing of his boiler in a setting of greater cost than asked for by his rival, and engineers apparently have not perceived that the cheaper mode of setting is alone responsible for all the expense in dearer fuel, smoke fines, nostrums, and experiments to which they have been subjected.

In questions of steam using as distinguished from steam production, engineers have certainly not erred in the direction of reduced first cost. Large amounts of capital have been expended on steam engines, on the buildings to contain them, and on tiles, mosaic work, and carpets over which to approach them, by men who would refuse to spend a shilling upon the more important department of steam production. The steam engine lends itself to impressive treatment. It looks well and gathers about it a very considerable amount of sentiment. Engine attendants have been known to weep over the scrapping from old engines. No man has been recorded to have wept over a steam boiler from any feeling of affection for the boiler.

The sentiment attached to the steam engine resulted in a rivalry which has done something to make the engine better, but an entirely false economy has arisen measuring the performances of an engine along lines which do not find a place in the life history of that particular engine. The old-fashioned idea of engine economy was based on the amount of coal consumed per indicated horse power. The indicated horse power was the unit employed because it was a unit that could be ascertained by means of the indicator with a reasonable approach to accuracy. The coal was the unit of consumption employed because it was easily measured and it brought into the sentimental rivalry the steam producer—and, so far, this was commercially sound, because it compelled the attention of the men in charge to the whole range of plant and not to one corner of it. It was partially because of this that the steam engineering of the cotton factory was always better than that of the electrical station.

The employment of coal as a basis of comparison is not held to be correct today, because it confuses the engine performance with boiler performance and prevents accurate information being secured from either. But it suited the mill owner who paid for so much coal and spun so many thousand pounds of yarn, and compared his results with those of his neighbour whose factory was so very similar to his own that the results were fairly indicative of the excellence of the engineer in charge.

The use of the indicated horse power as a unit was of course liable to give rise to error. It did, in fact, do so. It would have been better to have instituted further comparisons and taken into account the number of spindles turned per pound of coal and the indicated horse power. Discrepancies would have become apparent, and factories using 3 pounds of coal per indicated horse power might have been found to turn more spindles per horse power than other factories where the coal per horse power was 2¾ pounds per hour. The brake horse power was never known in those factories. Engineers rarely ran a friction load, to do which involved disengaging a toothed wheel or removing the driving ropes—a heavy and lengthy operation. In the absence of this information as to the brake horse power, the indicated horse power became the fixed unit of comparison and the result was to favour the excessively large engine and encourage the use of mean forward pressures much too low. It is also probable that the compound engine was encouraged unnecessarily. The compound engine no doubt frequently had a larger frictional load than the simple engine, and gained where coal was stated in pounds per indicated horse power in place of per brake horse power. In this way uneconomical errors crept into practice. In more modern installations of steam plant many errors have also crept in.

Striving after ultra-scientific accuracy, the steam-producing department has been put aside and separated from the steam-using and more fashionable department to which professors and *dilettanti* have given their attention to the exclusion of the unfashionable boiler. Much wisdom and disputation has been expended upon tests for dry steam, though it is well-known that there is no means of collection of true samples of steam and that the only proper steam to use is that which, when tested by a thermometer, is found to be something above its saturation temperature. The unreliability of many engine tests is amply illustrated by the records of 96 and 97 per cent. which some engineers have not hesitated to publish and to stick to. A sort of false doctrine of engine performance has sprung up, and engines are run for unnecessary hours at steady loads to determine their suitability for their daily load, which in cases of a traction or power-distribution load is never steady for many seconds at once and only at rare intervals approaches that load at which the engine is understood to be most economical, and at which its guaranteed performance has been paid for—perhaps to the extent of a bonus. Here again a lack of the sense of proportion in the engineer has caused the expenditure of unnecessary capital. At its steady full load, the compound engine at its proper pressure will be more econmical than the simple engine under similar favourable conditions. The economy of the compound engine is made up of several items. It has a smaller range of temperature in any one cylinder. It has less periphery of leakage in its pistons and valves exposed to boiler pressure; and it has less severe stresses. Taken together, it is more economical; but it is given high-pressure steam to work with, and much of the economy of the compound engine in reputation is what it earned when higher steam pressure was inaugurated simultaneously with the compound principle. One might ask in regard to the combined effect of compounding and higher pressure:

"Who was the potter then and who the pot?"

But while it may fairly be conceded that the compound engine is the better engine where compound-engine conditions of load and pressure are present, it may well be doubted if there has not been some misconception, some false notion of economics, at the root of the matter—our inability to grasp the true proportions of the subject. The cost of running any steam plant is made up of the capital charges on the cost, the cost of fuel and wages, and maintenance. Capital charges include those of buildings. Any falling off in engine economy may increase the capital charge on the boiler account, and this must not be forgotten. But the crux of the matter is the load. Every engine must be capable of turning the maximum load which may come upon it. In all compound engines the maximum load that can be turned is that represented by an admission of steam practically full-stroke of the first cylinder. The economical load is probably represented by a steam admission of a third or a fourth of the first cylinder. Thus at its maximum load the engine can use only three or four times so much steam as at its economical load, whence follows that for very variable loads, as in the case of all small tramway systems, the compound engine will be too large for its average load if it is able to turn its maximum load. Without going into the figures it is obvious that a simple engine of very much less size can be put down at less expense, which, while capable of turning its very occasional maximum load by means of full steam admission, will yet work ordinarily at its economic load. Being small, its piston and valve periphery for leakage will be little more than that of the larger compound engine. The use of superheated steam will eliminate much of those cylinder losses that have given the compound engine an advantage hitherto, and in addition there are the many considerations of weight and space which all tell in favour of the simple engine.

The object aimed at by the tramway engineer is not primarily to be even coal economy per kilowatt, for station economy will always be at its best where the coal economy is some distance short of best. Neither is it necessarily best economy to run the tramway at the smallest output in kilowatts per car mile. The minimum output is not consistent with the minimum of total costs. Capital charges on distribution mains are considerable, and in order to save mains it will pay to burn more coal and waste current in overcoming the resistance of smaller mains.

Engineers have too frequently confined their energies to the merely technical side of their profession, yet when technical knowledge has been required they have failed to possess it. They have, in fact, paid more attention to the more attractive departments. Hence the giving over of the steam-raising department to the business man, who has failed to perceive that the proper combustion of expensive fuel lies at the basis of economy. Hence also the expenditure of untold energy in perfecting steam engines to an academic pitch of perfection, to testing them on mere academic lines and under non-practical conditions as to load. Engineers have, in fact, allowed personal inclination and sentiment to override judgment, and the result has been that public sentiment and æsthetic instinct, poorly developed as they may be, have been outraged by the filth of incomplete combustion, for which the unjustifiable excuse is tendered that it is unavoidable. The same lack of the sense of proportion is also specially characteristic of the architect, who whether he is providing steam-plant accommodation or looking after sanitary necessities, appears to exercise a particular malevolence toward these branches of a profession he does not understand, until an architect's engineering or sanitary work has become a bye word and a reproach. A familiar example of uncommercial engineering is afforded where on a line of electrical tramway of very few miles in length a high-tension system of transmission with sub-station transformation is employed. There is a point where high-tension systems must obviously be employed, but good judgment must be exercised before adopting it.

Every up and down transformation of energy involves a loss of probably not less than 3 nor more than 5 per cent. In high-tension transmission there is a loss in the step-up transformation from the pressure of generation to the line pressure; a loss in stepping down; a loss in transformation to direct current. The three losses may leave only 85 per cent. of the generated current to go out on the line.

Expensive machinery is involved and complicated switch-boards and substation buildings. Cables must be provided in any case, and the cost of these will be a large proportion of the cost of low-tension cables. The cost of laying may be but little less. The cost of insulation will be at least greater per pound of copper. If all the additional expense of transformation were put into extra copper in the distribution cables for a low-tension system, it is probable that the commercial limit of the low-tension system would be moved considerably upwards. Moreover, copper in mains has a scrap value much above that of an equal first cost of sub-station, switch gear, and machinery. A loss of 10 to 15 per cent. of current, which is inevitable in the high-tension transformation, allows of considerable loss in a direct-current system.

There can be no question as to the economy to be derived from working on the condensing principle. Especially is this the case where, as in traction work, the mean pressure is low. By condensation it is claimed that as much as 40 per cent. economy may sometimes be secured. Many power stations are placed away from a free source of water, and great expenditure has been incurred in providing special means of cooling the water, such as towers and fans. This involves a considerable waste of power and it is doubtful in many cases if the expenditure of power on fans is worth the difference between a fan tower and a natural-draught tower. Here also comes in the question of high-tension transmission. If it is ever worth while to incur the complication of a high-tension system, it should be made to afford the engineer some latitude in the choice of a site easy of access for coal and water, so that the full benefit of condensing may be made to represent an advantage on the side of the high-tension current.

In almost no case can an engineering economy ever be pushed to its full face value. There is always some point short of maximum primary economy at which it is desirable to draw the line. Almost all curves of performance on economy approximate to the hyperbolic order. There is a rapid start, and then beyond a certain point the curve becomes more and more flattened and parallel with a straight line.

Even in an adiabatic cylinder of a perfect steam engine the gain due to further expansion of the steam is so small beyond a certain point that the size and cost of a steam engine would become excessive, and interest costs would eat up fuel saving. In practice, the extra friction of a large engine puts an early limit on expansion, and the action of the cylinder metal still further limits the possible economy of expansion

Similarly in ocean steamships the commercial limit of speed is reached sooner than recent examples would lead one to believe.

The absolutely callous indifference of the Atlantic greyhound to all small craft may someday produce such disaster as will upset the public sentiment for saving an hour on a week's voyage, which alone has so far enabled the fastest ships to pick up the cream of the traffic, and to sacrifice everything to speed by filling up their whole space with power plant.

No matter which way we may turn, we are confronted with the fact that efficiencies, economics, and costs do not run in straight-line curves, and that it is unsafe to assume a long-continued curve from a few points in its early development. This assumption has been a cause of immeasurable miscalculation and commercial failure. Processes and improvements that, like the lower grades of steam expansion, show huge economies, do not continue to show a uniform rate of economy and a limit is soon reached to progress in any one direction. It is the same in mining. The last grain of gold per ton cannot be got at a cost which pays for a white man's process and a white man's living rates. Some fraction must always remain, out of which the Chinaman can fossick out a living on a less luxurious plane.

Such instances might be multiplied an hundredfold. They show a lack of the sense of proportion, without which engineering cannot be carried out on the lines of that true economy which is included in the term "Commercial Engineering."

MODERN MACHINERY FOR EXCAVATING AND DREDGING.

II.—DREDGES FOR TIDAL HARBOURS AND DEEP WATERWAYS.

By A. W. Robinson.

In a preceding article Mr. Robinson pointed out the great and increasing influence which economy of transportation has upon commercial prosperity, and discussed the steam shovel and the dredge as the principal means for increasing that economy by preparing the way for the efficient carriers of cheap freights—the locomotive and the large steamship. The first half of his review dealt more particularly with machines for cutting the roadways of internal communication. This takes up the heavier types more closely adapted to harbour work or deep waterways, such as the Isthmian Canal.—THE EDITORS.

HAVING described in the former article the steam shovel for land excavation, and the first two types of dredging machines for sub-aqueous dredging—namely, the ladder dredge and the dipper dredge—it now remains to describe the hydraulic and the clamshell types of dredge.

The hydraulic dredge is a later development and bids fair to outstrip in importance the other three. It is yet in its earlier stages, and its possibilities are but imperfectly understood. It is more sensitive than other types to suitability of conditions, and is therefore a special and not a general-purpose machine. The dipper type of dredge may be what is termed an "all-around" dredge, and may work in a variety of material and under different conditions. The hydraulic dredge on the other hand, in its earlier forms at least, is restricted to soft or homogeneous material, although later forms of mechanical cutters have greatly widened its usefulness. Its strong points are continuous operation, large capacity, and facility of transporting and disposing of the material as well as dredging it.

Hydraulic dredging has been known and practiced for about forty years, although it has been slow of development, and of late years it has been retarded by litigation in the courts over patent rights.

The first important consideration in a hydraulic dredge is the character of the material, and the second the method of its disposition. Perfectly free material, such as sand or soft mud, can be pumped by the suction alone: but more compact ground such as clay, stiff mud, or earth requires to be mechanically excavated. The main function of the hydraulic action is the transportation of the dredged material, and it has been largely because of this feature that this type of dredge is able to show such satisfactory results.

FIG. 20. SEA-GOING HOPPER DREDGE GRAMPUS, GOVERNMENT OF NATAL.

Twin-screw suction pump. Hopper capacity 1,200 tons; pumping capacity 3,000 tons per hour. Wm. Simons & Co., Ltd., Renfrew.

Theoretically, the transportation along with the dredged material of four or five times its weight of water, and the pumping of it against high heads at high velocities with great loss by friction in the pipe, is a very wasteful proceeding; but all dredging methods are wasteful, and the percentage of useful work done in proportion to power expended is very small. The most practical measure of efficiency, therefore, as a basis of comparison with other types, is the cost per cubic yard of material dredged and deposited at a given distance and under given conditions. Measured by this test and under suitable conditions, the hydraulic dredge can be made to show good results, and the cheapest dredging yet recorded has been done by this type.

There are advocates of the hydraulic dredge who make extravagant claims for it and who know no other type. It is well to recognise the limitations of each type, and in carrying out a given piece of work so to

The numbering of the figures is consecutive with that in Mr. Robinson's article in THE ENGINEERING MAGAZINE for March, 1903.

adapt the means to the end that the best results will be secured. Each type has its own value in its own field of work; the other types can do work that the hydraulic type cannot do at all, and *vice versa.*

Briefly, the hydraulic dredge may be divided into four leading types:

1.—The sea-going hopper type.

2.—The lateral-feeding or ship-channel type with floating discharge pipe.

3.—The forward feeding or Mississippi type, with floating discharge pipe.

4.—The radial feeding, with spud anchorage and floating discharge pipe.

An example of the first or sea-going hopper type is illustrated in Figure 20 by the dredge Grampus. This vessel is one of several built by Wm. Simons & Co., of Renfrew, Scotland, for the government of Natal. The Grampus is 218 feet in length, 30 feet 6 inches beam, and 16 feet 7 inches deep, and has a hopper capacity of 1,300 tons. It has a suction pipe 44 inches in diameter which is fitted in a central well in the fore part of the dredge and is flexibly connected in such a way that the dredge can plunge about to a great extent in sea waves without interfering with the operation of dredging. These dredges are naturally subject to delays from storms, etc., and having to transport the material to sea the actual dredging time is comparatively small. For this reason the pumps are given very large capacity so that the hoppers can be filled in about thirty minutes. A similar dredge called the Walrus in 1899 dredged and deposited at sea 1,103,000 tons of sand at a cost per ton of 1.984 pence. This is equal to about 760,000 cubic yards at 5.75 cents. Dredges of this type are necessary for deepening the bars that form at the mouth of nearly all rivers which carry alluvial matter, or have a sandy estuary.

In Figure 21 is shown a smaller dredge of this type called the Forshaw. This dredge was built in 1897 by Lobnitz & Co., of Renfrew, Scotland, for the River Ribble Navigation Commissioners of England. This dredge is 117 feet long, 36 feet beam, and 14 feet deep. It has a hopper capacity of 20,000 cubic feet. It has one triple-expansion engine of 650 horse power which drives the propeller and also drives the centrifugal dredging pump, which is connected to the forward end of the engine by a clutch. The suction pipe goes through the side slightly below the water line and leads forward, terminating in a plain end with grating. The method of dredging is to drop the bow anchor and feed slowly forward, the suction pipe making a conical hole or trough in the

FIG. 21. SEA-GOING HOPPER DREDGE FORSHAW, WEST COAST OF ENGLAND.

bottom as the sand flows to the suction pipe. The dredge carries a crew of eight men and a boy, and dredges and deposits the material a distance of 12 miles for a cost of about one penny per ton. The cost of the vessel complete was £20,000. This dredge represents the hopper type in a very simple form and cheaply operated, and for the particular work it has to do it is very satisfactory. It was followed in 1899 by a duplicate dredge. Owing to the high tides on this river, navigation is entirely suspended at low water, as the river empties out nearly dry. The dredge is thus able to make only one trip on each tide, and under these circumstances the performance is very creditable.

In Figure 22 is shown the large sea-going hopper dredge Thomas. This dredge is one of two which were built in 1900 by the Maryland Steel Co., at Sparrows Point, Maryland, for the Metropolitan Dredging

FIG. 22. SEA-GOING HOPPER DREDGE THOMAS, NEW YORK HARBOUR.

Company of New York for the deepening of the outer channel of New York harbour. These vessels are stated to be the largest dredges in the world. They are modelled after the dredges Brancker and Crow, which have done such successful work for the port of Liverpool at the mouth of the Mersey. They are, however, more capacious than the English dredges, being 300 feet long, 52 feet 6 inches beam, and 25 feet deep, and the hoppers have a capacity of 2,800 cubic yards. The Liverpool dredge Crow is illustrated in Figures 24 and 25. The contract on which the Thomas is engaged is to remove 40,000,000 cubic yards of sand at 9 cents per cubic yard. These vessels have been described and illustrated in various periodicals, so that a detailed description of them is not necessary here.

FIG. 23. VIEW ALONG THE DECK OF THE SEA-GOING HOPPER DREDGE THOMAS.

A number of sea-going hopper dredges, of comparatively small size have been built for the United States government for the various ports along the Atlantic Coast. Among these may be mentioned those at Cape Fear River, Winyah Bay, S. C.; Charleston, S. C.; Pensacola, Florida; Sabine Pass, Texas, and Galveston, Texas. These dredges were built by contract from designs prepared by the U. S. Corps of Engineers. For the most part they have wooden hulls, wood being preferred to steel as being more elastic in case of pounding on the

FIG. 24-25. SEA-GOING HOPPER DREDGE G. B. CROW, PORT OF LIVERPOOL, AND VIEW ALONG HER DECK.

shallow bars, and it is considered by some to be more durable than steel in the semi-tropical waters of the South Atlantic. The increasing scarcity of wood will, however, eventually cause it to be abandoned for hull building.

The power required for pumping is much less in the hopper type of dredge than in the other three types using a long discharge pipe to transport and deposit the material. For long-distance pumping the power required is very great in order to overcome the friction in the pipe at the high velocity. A pump that will do fair work in hopper loading would be useless for long-distance work. Such pumps must be specially designed, and in many cases must be capable of overcoming a total head of 80 to 100 feet.

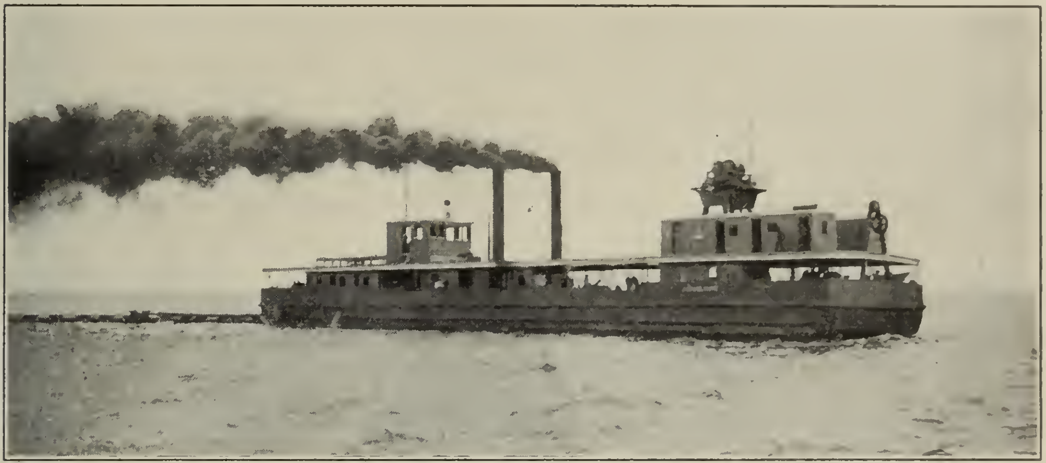


FIG. 26. HYDRAULIC DREDGE J. ISRAEL TARTE, ST. LAWRENCE RIVER.

The second type of dredge is that having a lateral feed and is exemplified by the dredge J. Israel Tarte in Figure 26. This is, in fact, the only hydraulic dredge of which I know that has a lateral feed of 450 feet, so that it can make a ship channel of that width in one cut. This dredge was built in 1901 from my designs by the Polson Iron Works of Toronto, Ontario, for the Canadian government, and is employed in deepening the ship channel of the River St. Lawrence below Montreal. The hull is of steel, 160 feet long, 42 feet beam, and 12 feet 6 inches deep, and the main pump has a suction pipe 40 inches in diameter, with 36-inch discharge pipe 2,000 feet long. The dredge is operated entirely by wire-rope anchorages, and the suction pipe passes through a well in the centre of the vessel. The material in which this dredge works is blue clay and it is excavated by a mechanical cutter. This cutter is 9 feet 6 inches in diameter and weighs 10 tons, and with its engines and mountings is of the most substantial description so as to avoid possibility of breakdown or delay. The mooring ropes are

FIG. 27. PIPE LINE OF HYDRAULIC DREDGE J. ISRAEL TARTE.

arranged in such a way that the operation is practically continuous. During the month of September, 1902, the output of this dredge was 580,000 cubic yards, and in October 600,000 cubic yards, or 1,180,000 cubic yards for two months. This was in 26 working days per month of 24 hours. As far as I am aware, this marks a world's record for output, measured by the month, of any dredge under any conditions.

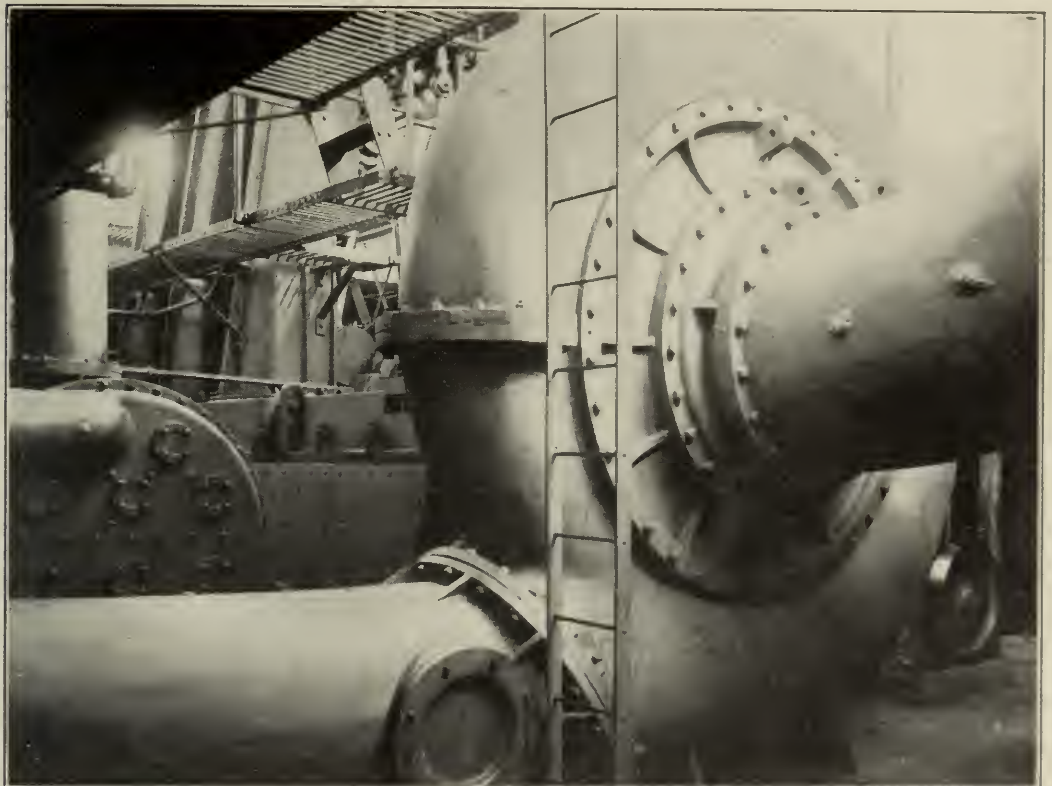


FIG. 28. MAIN PUMP OF THE HYDRAULIC DREDGE J. ISRAEL TARTE.

The quantity of work done was ascertained by taking the position of the dredge on the first of the month and again on the first of the following month, and measuring the distance of length of ship channel completed in that time. As the cross-section of the cut was practically uniform and the material blue clay, which remains permanently in place, the work of the dredge could thus be arrived at with a fair degree of accuracy. The quantity stated is increased to scow measurement to compare with the other dredges on the same work which load into scows, on the basis of place measurement being 80 per cent. of scow measurement. Larger outputs per hour have been claimed for sand-pump dredges on the Mississippi and elsewhere, but these tests were made for a few minutes only by barge tests, and in loose sand and at comparatively shallow depths. I believe that the only proper way to measure the work of such a dredge is as described for the Tarte, and charge to the dredge all delays of whatever kind.

The main engines of the Tarte are of the triple-expansion type of 1,000 indicated horse power.

FIG. 29. HYDRAULIC DREDGE EPSILON, MISSISSIPPI RIVER.

It thus appears that America possesses the largest and most costly dredge in the world, as exemplified in the Thomas and Mills in New York harbour, and the dredge holding the world's record for the largest output for two consecutive months in the J. Israel Tarte, of Canada. It will probably not be long before these records are exceeded, as the modern tendency is towards large power and capacity.

We come now to the third type of hydraulic dredge, or forward feed, as exemplified by the great dredges of the Mississippi River. This type is illustrated by the dredge Epsilon, in Figure 29. The Epsilon is the fifth dredge of a series of ten dredges which have been built for the Mississippi and Missouri Rivers. It was built in 1898 at a cost of $102,000 and has a steel hull 157 feet long, 40 feet beam, 7 feet 9 inches deep, and draws 4 feet of water. The main pump has 32-inch discharge pipe 1,000 feet long, and the main engines are of 650 indicated horse power. Steam is furnished by boilers of the externally fired Mississippi River type, 48 inches in diameter by 28 feet long, the working pressure being 150 pounds. Some of the later dredges have been made self-propelling with side-wheels, and improved in detail, but the general type is the same. The details and results of these dredges have been already fully published.*

* Trans. Am. Soc. C. E., June, 1898.

These dredges are stationed along the river at various points during the low-water season for the purpose of opening a passage through the sand bars which obstruct navigation. The bottom of the river is continually changing and these sand bars do not make trouble until the low-water season; it is then necessary to do a large amount of work in a very short time in order to afford relief and permit the passage of the river steamers. The dredge therefore makes a straightforward cut across the sand bar, making a passage about the width of itself at a rate of advance of from 10 to 30 feet per minute. The floating discharge pipe deposits the sand in the deep pool below the bar, and the dredge is hauled ahead by means of steel-wire ropes attached to anchor piles which are sunk in the sand by the hydraulic method. These dredges work to a depth of 12 to 20 feet and have proved very satisfactory in service for the purpose intended. The alluvial formation through which the river flows is such that the work done has no permanence, and it therefore represents a continual expense each year; and on account of the short season and intermittent work, the total number of cubic yards dredged is comparatively small.

FIG. 30. HYDRAULIC DREDGE NO. 2, NEW YORK HARBOUR, LOADING TWO 1,800 YARD BARGES SIMULTANEOUSLY.

The initiation of this method of dredging on the Mississippi River is largely due to the efforts of the late Henry Flad, M. Am. Soc. C. E., who began his experiments which culminated in the dredge Alpha at a time when no such dredges were in existence, and when his ideas as to dredging sand on such a scale were thought to be chimerical. The Alpha was built in 1893 and had a wooden hull 140 feet by 36 feet by 8 feet, with a centrifugal dredging pump having 30-inch discharge and of 300 indicated horse power. The success of this dredge was undoubted, but it was felt to be largely in the experimental stage and the Misissippi River Commission called publicly for plans to be submitted for the best dredge of this type. After considering some twenty proposals they reduced the number to three, and awarded a contract to each of the three bidders to construct their own designs with a view to ascertaining by experiment the results of each. This resulted in the construction of the Beta from designs by Lindon W. Bates, of the Gamma from the writer's designs, and of the Delta from designs by the New York Dredging Co. The comparative cost and efficiency of the three dredges is exhibited in the following table:*

Dredge.	First cost.	Operating expenses per day.	Test Output.	
			Average cubic yds per hour.	Cu. yds. per horse-power per hour.
Beta	$218,162	$221.63	4,920	2.00
Delta	124,940	111.76	1,829	1.62
Gamma	85,530	100.51	1,523	3.28

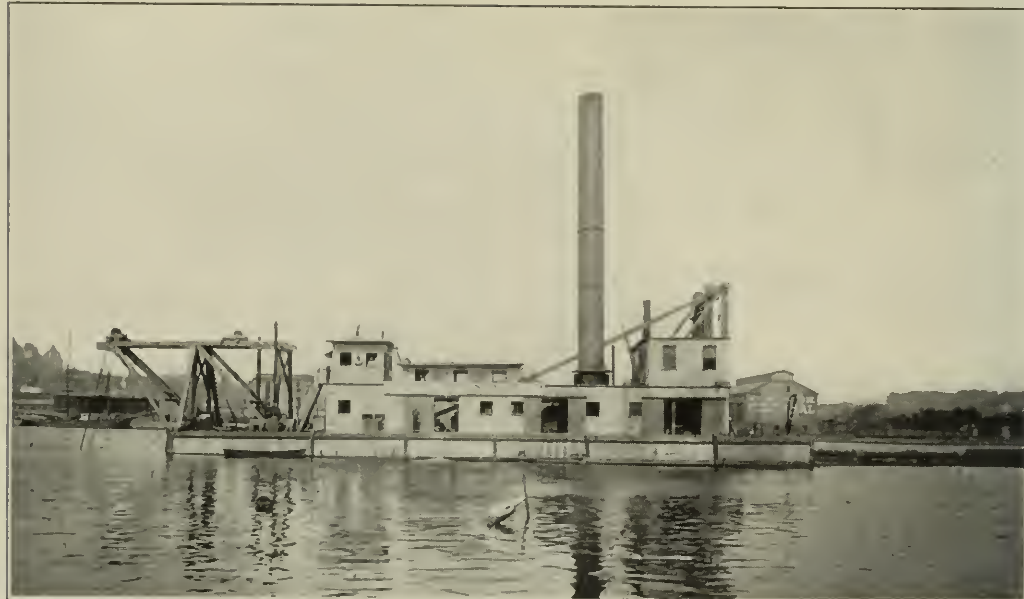


FIG. 31. HYDRAULIC DREDGE NO. 3, ALBANY, N. Y.

The fourth type of hydraulic dredge, or that of radial feeding with a stern spud anchorage, is exemplified by the dredge King Edward and illustrated in Figure 32. This type of dredge is specially adapted for pumping material ashore and making land, etc. This kind of work is illustrated in Figure 33, which shows the dredge in the distance and the manner in which the material spreads itself by hydraulic action. This dredge was built from my designs for the Canadian government, for the Pacific Coast port of British Columbia. Being intended to do a variety of work at points distant from one another, it is made self-pro-

* See "Correspondence on Dredges and Dredging." Trans. Am. Soc. C. E., Vol. XL., p. 347.

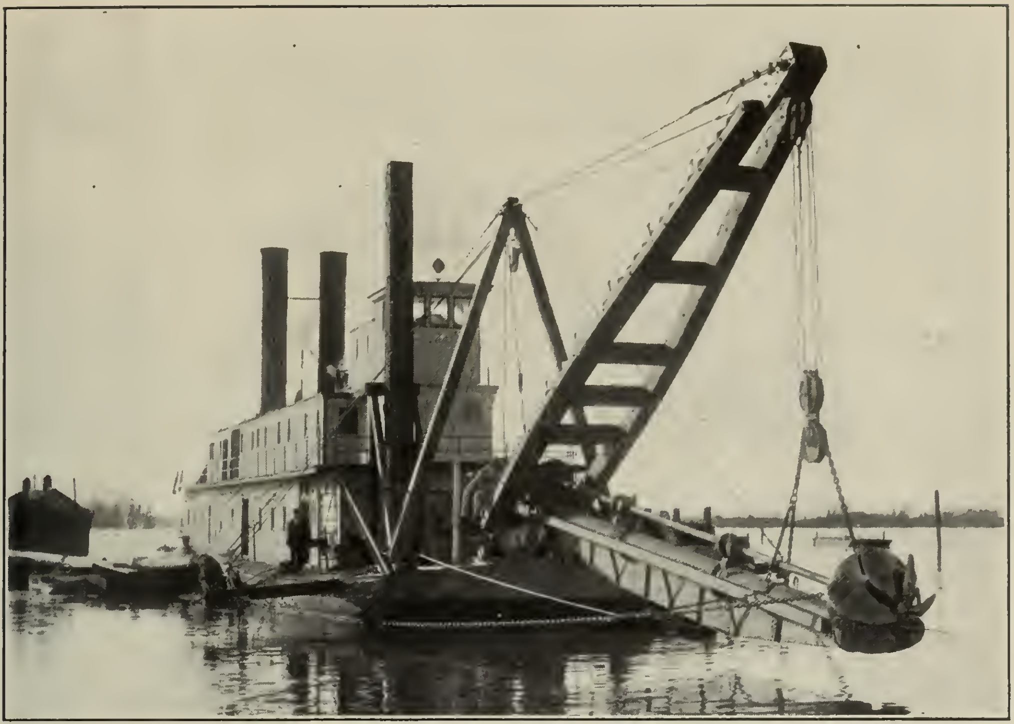


FIG. 32. HYDRAULIC DREDGE KING EDWARD, BRITISH COLUMBIA.

FIG. 33. SHORE DISCHARGE OF HYDRAULIC DREDGE KING EDWARD.

FIG. 34. 20-INCH HYDRAULIC DREDGE, VICKSBURG, MISS., MAKING NEW CUT TO RESTORE RIVER NAVIGATION TO THE CITY.

pelling by means of a stern wheel of the river-steamer type so much used in the West. The hull is of composite construction and is 125 feet long, 32 feet wide, and 7 feet 6 inches deep. The suction pipe projects over the bow and is of the universal swing type, that is to say it can swing upon the hull while the latter remains stationary, thus making it useful in getting into corners and confined places. It can also make a cut 125 feet wide by swinging the entire dredge on a stern spud. The dredge is fitted with a mechanical cutter with renewable steel blades. The suction and discharge pipes are 20 inches in diameter. The engines are of the triple-expansion type, of 500 indicated horse power. This dredge has developed a capacity of 800 cubic yards per hour under favourable conditions and can pump material to a distance of 3,000 feet. The upper deck is occupied entirely with quarters for the officers and crew. The contract price of the dredge was $92,515, delivered under steam on the Pacific Coast.

Another dredge of the radial type is illustrated in Figure 34. This is a 20-inch dredge belonging to the Atlantic Gulf and Pacific Co., of New York. The illustration shows the dredge at work making a canal which is intended to restore river navigation to the city of Vicksburg, Miss. In Figure 31 is illustrated a similar dredge belonging to the same company. In these dredges, however, the suction pipe does not swing on the hull but is mounted on a frame which has a rising and falling movement only in a well in the fore part of the dredge.

The clamshell type of dredge is found mainly along the Atlantic Coast where the conditions are best adapted for its use. It is essentially a machine for working in soft material and loading scows. It is usually anchored by means of spuds, but as these are not subjected to lateral strain due to digging, as in the dipper dredge, they may be comparatively light and yet hold the dredge from moving about in the deeper water of the coast. The clamshell type of dredge is also well adapted for digging to great depth for foundation work, etc., in which case the spuds are dispensed with and the dredge maintained in place by anchorage. A usual type of clamshell dredge along the Atlantic Coast is illustrated in Figure 38. In Figure 35 is illustrated the clamshell dredge Fin Mac Cool. This was built by the Osgood Dredge Co., of Albany, N. Y., for work at Buffalo, N. Y., where it excavated the foundations for the Buffalo breakwater in 90 feet of water and was afterwards taken to the coast via the River St. Lawrence. This dredge has a record of 140,000 cubic yards per month in ordinary soft material from 30 feet of water.

FIG. 35. CLAMSHELL DREDGE FIN MAC COOL, BUFFALO, N. Y.

In Figure 36 is illustrated a special type of clamshell largely used in California, in which the opening and closing of the bucket is by levers directly attached to the two halves. Another application of the clamshell type is seen in Figure 37, in which a long boom is used for depositing material on the shore.

I have now described the four types of modern dredges, with examples of each, but the subject is such a large one that it is impossible within the limits of a paper like this to do more than touch on salient points. Enough has been said to show that during the last five years a great improvement has taken place in this class of work in America, and that the country now has some creditable examples to point to. Much still remains to be done to remove present practice from the empirical notions of the individual to a recognised basis of good engineering. In no branch of mechanical engineering are the definite results of experience so necessary and valuable, or the theoretical ideas of the novice so likely to result in failure.

The value of powerful and efficient dredging machines as a means to accomplish large works of national importance can hardly be over-estimated. Works of magnitude not thought of (or deemed impossible) a few years ago, can now be undertaken with confidence. As efficiency increases with size in the steamship and locomotive, so it does in the dredge; and with large and modern tools enormous capacity can be reached.

The great expansion which has taken place in the size of steamships makes necessary the improvement of harbours and channels all over the world. This must keep pace with the vessel improvements if the

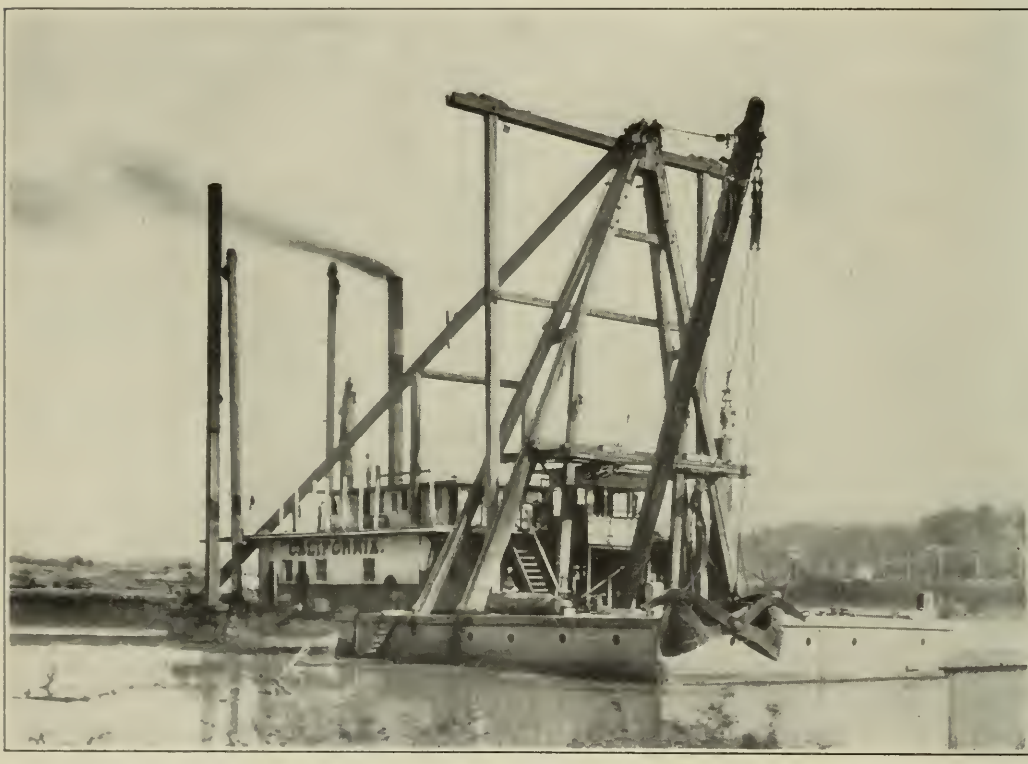


FIG. 36. CLAMSHELL DREDGE, CALIFORNIA TYPE, VICKSBURG, MISS.
5.6-yard (struck) bucket.

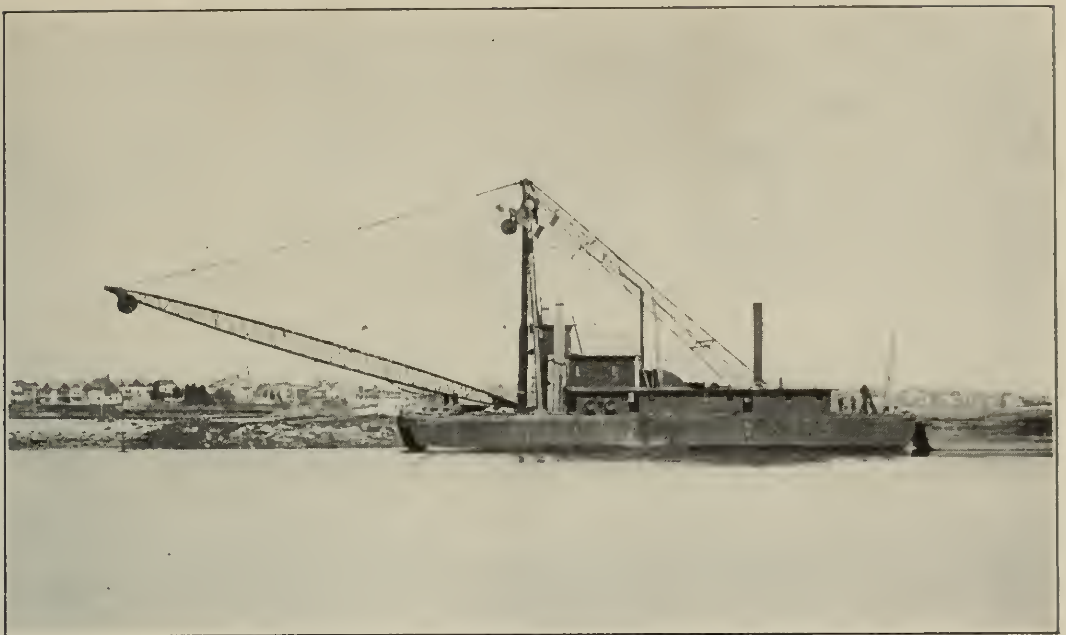


FIG. 37. CLAMSHELL DREDGE WITH LONG BOOM, NEW YORK.

best results are to be obtained, but at present it must be said that the vessels lead in the race, and it is "up to" the harbours everywhere to provide accommodations for them.

Internal waterways also occupy a large share of national attention and national expenditure, but it is astonishing how little attention is devoted to the economy represented by the mechanical efficiency of the dredging tools used in building and maintaining them. A saving of only one per cent. per yard means ten thousand dollars on each million yards of work.

The Isthmian canal is now occupying public attention, and bids fair soon to reach a stage at which actual construction will be begun. The plan and prospects are now more promising, and the prospective result more momentous, than when the brilliant scheme of De Lesseps at Panama failed so lamentably. We have not waited in vain. We have now a better knowledge of the conditions, better engineering skill with which to conquer them, and tools of which De Lesseps never dreamed available for the execution of the work.

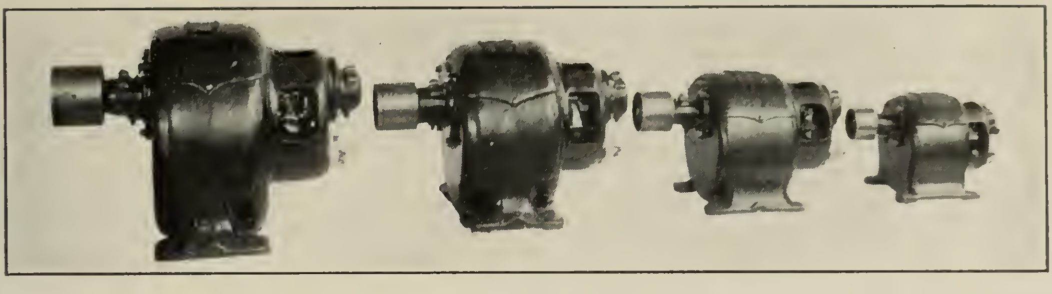
The work situated as this is a long distance from the base of supplies, and where skilled labour is expensive, it is of great importance that machinery should be simple and strong and easily operated without manual effort. The value and importance of modern machinery of large capacity increases as the cost of labour, skilled and unskilled, increases. On the Central American Isthmus the labour question is a serious one. Native labour is inefficient, and cannot be used for any skilled

FIG. 38. CLAMSHELL DREDGE, NEW YORK.

operation. Imported labour is costly, and elaborate systems of sanitation must be adopted. Physical exertion in that climate is impossible for any length of time. Hence labour-saving devices are essential, and specially designed tools of large power and capacity must be adopted, in which the skilled man will be the brain and not the muscle.

Formerly an army of men would be necessary to carry out such a gigantic work, and the mortality inevitably large. Now it is possible to accomplish the work with powerful machinery, adapted to operate with but few men, and with proper care and sanitation the loss of life need not be large.

In these articles I have only touched upon the principal types of machinery used in this class of work and indicated in a general way the progress that is being made. For the future we may expect great advances, especially in the direction of economy of results and greater reliability in service, so that more work can be accomplished for the money and time expended than ever before. The large power and great capacity of tools now available for public works makes it not only possible, but economically advantageous, to plan them on a large and comprehensive scale. The advantage conferred by great size and power must, however, be used with great caution and skill, otherwise we will see examples of great and ambitious machines which may be first-class in the main, and yet contain errors and misfits of design that may entirely nullify the benefit to be derived from the otherwise general excellence.



THE DEVELOPMENT AND USE OF THE SMALL ELECTRIC MOTOR.

By Fred. M. Kimball.

Mr. Kimball's entire professional experience has been specialized upon the application of the electric motor to industrial uses. The keynote of his treatment of the subject in the articles begun this month is practical economy and commercial success. He keeps always in plain view the working conditions of the ordinary shop and the limitations of the ordinary shop workman. He meets the questions which present themselves to the workshop owner or superintendent, showing just where and how economy will be promoted by the introduction of electric driving, what points must be considered and what methods pursued in the installation of electric motors, and what effects on shop practice or organization will follow. The treatment, while primarily related to the machine shop, will have wide application to all manufacturing industries. The second article, in our May issue, will deal with the practical effects of "The Electric Motor in the Machine Shop."—The Editors.

ALTHOUGH the public is fairly acquainted, in a general way, with the uses of electricity, it has little idea of the vast number of specific applications to which this intangible but most potent force has been applied. Neither does it comprehend very clearly the construction of the apparatus by which the power of electricity may be made manifest.

About the first commercial application of electricity on a large scale was known to the public in the form of the telegraph. Afterward came the electric light and the telephone. Following these applications the employment of electricity as a means of distributing and utilizing power was widely heralded. The operation of street cars by means of electric motors has probably been the principal means of bringing the subject prominently before the people.

But few people have any intimate knowledge of the use of electricity and electric motors when employed so prominently for transportation purposes, and even fewer still realize the extent to which small electric motors are used in connection with the thousand and one affairs of our daily life.

We find them everywhere, regardless of geographical location, and used in connection with almost every commercial, domestic, and manufacturing purpose, as well as contributing to the means of our pleasure and recreation. An attempt to indicate all the principal lines of industry in which small motors are now successfully employed would require the preparation of an article which would extend into volumes

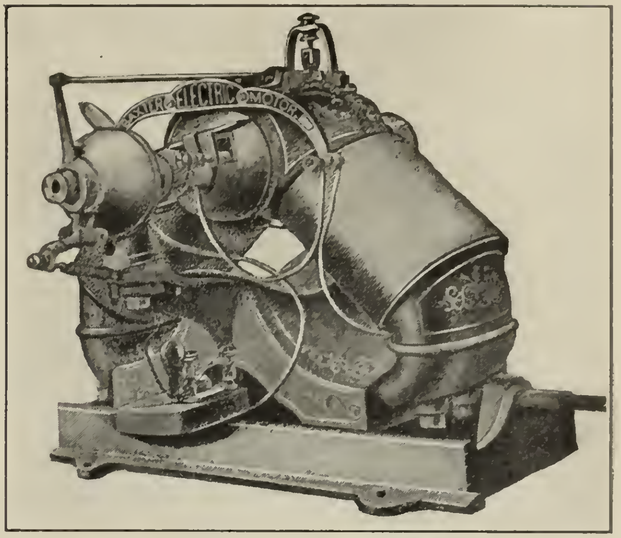
Up to the early 80's, the electric motor was considered rather more as a toy or an interesting piece of experimental apparatus than as a machine which would later revolutionize existing methods of producing, transmitting, and distributing power.

We need but lightly touch on the discovery of the principles upon which the manufacturer of small motors depends, nor need we go in detail into the earlier work done by Ampère, Jacoby, Faraday, Siemens and others. We cannot, in justice, however, proceed without at least mentioning the valuable contributions which they made to the art.

Faraday's grand discovery of the convertibility of generators into motors, and *vice versa*, was made in 1831. In 1832 Pixii in France designed and built his magneto-electric generator, which was a very distinct advance in the way of practicality over anything previously achieved. In America Charles G. Page of Salem constructed in 1835 a magneto-electric generator which foreshadowed many of the essential principles now in use. The Siemens shuttle armature with the two-part collector was brought out in 1856 .

A large number of scientists and investigators were adding to the sum of knowledge during the next ten years, but perhaps the most valuable acquisition was that contributed by Antonio Pacinotti, an Italian, who, in 1860, devised his toothed-ring armature which is the prototype of all iron-clad armatures so extensively used in the present day. In 1864, Pacinotti built a very satisfactory continuous-current machine. Prior to this time, nearly all of the generators had been of the alternating-current type; and just here we should note that the first generators produced only alternating currents, and one can well understand how, by perhaps a slight turn in the wheel of fortune, some inventor might have commercialized the early alternating-current generator and motor, and we should not have gone through all the phases of development which have led from the older forms through direct-current machinery and now back again to alternating-current apparatus.

Gramme, in France, showed before the French Academy in 1871 the celebrated ring-wound armature which bears his name, and this Gramme armature seems to mark the advent of the first really practical dynamos and motors, which were used for commercial purposes.

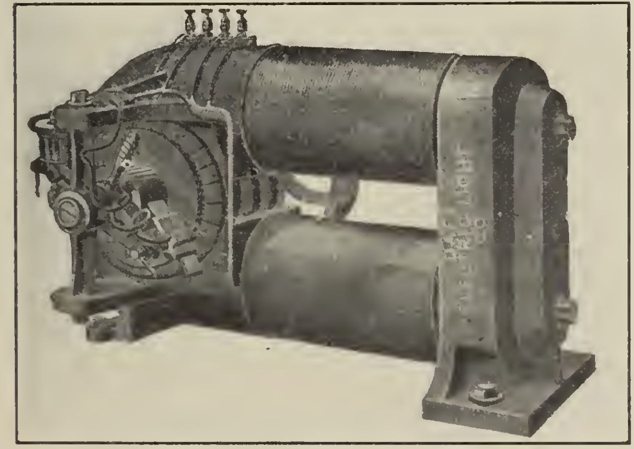


AN EARLY TYPE BAXTER MOTOR.
A historic form, used on arc-light circuits.

To one who is much interested in electrical engineering, there is no more fascinating diversion than to study the contributions made from time to time by the earlier investigators, and to peruse the notes which they left behind. The whole industry is so young that it is comparatively easy to trace, step by step, the different phases of the development of modern dynamos and motors, and to determine with a considerable degree of accuracy to whom the introduction of each vital element in design is justly attributable.

The small motor as we know it to-day is essentially a product of the most drastic evolution. When motors were first put on the market the principles of construction were comparatively little understood, and the result was that if a manufacturer could supply a machine which would not burn itself out within twenty-four hours, and which could be caused to "mote" for a few days without too many stoppages, he was pretty well satisfied.

All the early motors were supplied with copper brushes and there was a wide disagreement, often the subject of heated discussions between the agents of competing manufacturers, as to whether copper-wire brushes or copper-leaf brushes were the better.



AN EARLY DAFT MOTOR.

Many of the early motors had commutators made of brass, and sparkless operation through wide fluctuations of load was rarely accomplished; again, the zinc would burn out of the brass segments, thereby leaving the face of the commutator very rough indeed, and inducing severe wear on the brushes. While theoretically a pure shunt-wound motor possesses the best elements of design for general purposes, nearly all the very early motors were series-wound. The speed regulation in the shunt-wound motor is good; its effective torque is high, and it is cheaper to build than any other motor having fair speed-regulating qualities, but its current supply must be derived from constant-potential circuits.

As arc lighting preceded incandescent lighting, constant-current circuits only were available for current supply to the motors first used for commercial purposes. Hence, nearly all of these early motors were designed for operation on arc-light circuits and were series-wound. Three of the most prominent of these motors were, respectively, the "Cleveland," "Baxter," and "Excelsior."

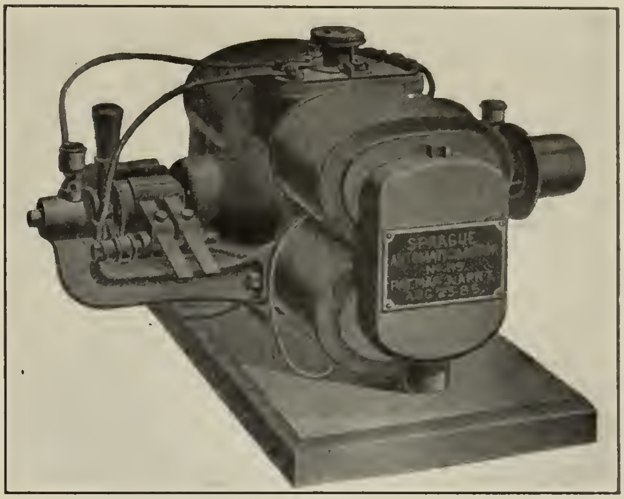
Much ingenuity was shown in the methods used for obtaining speed regulation, a very usual method being to vary automatically the number of turns in the field winding and thus increase or decrease the field strength to correspond with the load on the motor. Owing to the difficulties of effecting satisfactory speed regulation in series-wound motors, and for other causes, they were largely abandoned in favor of shunt-wound motors, except for special purposes, as soon as the constant-potential circuits needed to supply incandescent lamps became generally available.

Gramme-ring armatures were quite in favor for some of the early small motors, although a shuttle winding of the Siemens type presented less difficulties in manufacture. Drum winding was a *terra incognita* to the majority of builders. One of the prominent motors of this early day, in order that it might possess fair angular velocity and no "dead point" with shuttle winding, was provided with two armatures mounted at right angles with each other on the same shaft, the winding being led to a double two-part commutator so arranged that a single pair of brushes would complete the circuit. We should ridicule such an arrangement at the present time, but it was considered to embody a very bright idea when first put upon the market.

In the early days the proportioning of windings among themselves, or to iron, was little understood; field reactance, armature coercion, and other elements which are now looked upon as most important, received very little attention. The windings were proportioned largely with a view of keeping the heating low, and sufficient iron and wire were used to obtain what each individual producer considered to be "a good strong field magnet."

Air gaps were thought of comparatively little importance except to give clearance, and an intimate knowledge of fluxes, while at times talked of glibly, was considered by the practical manufacturer of motors as a scientific subject which it was hardly worth his while to waste much time on. What he wanted was a motor that would "go" and not burn up, and if he obtained that he was pretty well satisfied.

All of the motors constructed at this time were of the open type—a favorite form consisting of a base on which were mounted the magnets and pedestals for carrying the armature. Enclosed motors were not in demand, and multipolar machines had hardly been thought of. Rheostatic speed control, when any control was required, was almost universal.

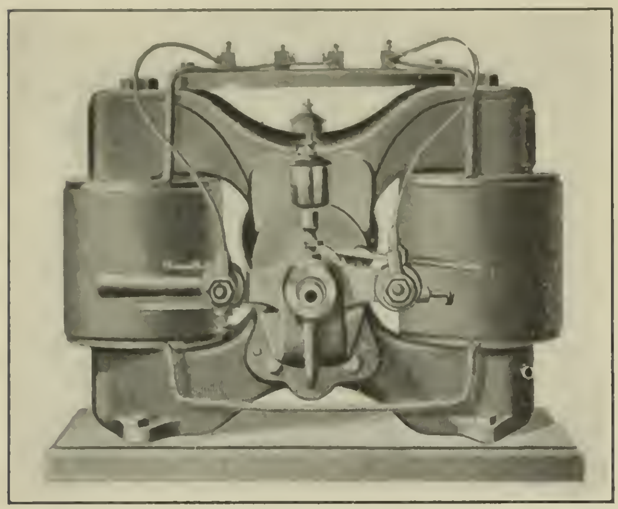


AN EARLY TYPE OF SPRAGUE MOTOR WITH COMMUTATED FIELD AND HEADBOARD SWITCH.
1 horse power. This is one of the earliest forms.

Users of power in small amounts were not slow to recognize the value of the electric motor, and with the advent of more widely extended direct-current circuits on the Edison three-wire system, the demand for motors increased, and the requirements of customers became more severe so that manufacturers found it to their advantage to give a large amount of attention to improving the operation of their motors and decreasing the costs.

The brilliant work of Mr. Frank J. Sprague, about the year 1885, in producing, as a result of his own practical experiments and the theoretical investigation of himself and others, electric motors which were sufficiently sturdy in design, reliable in operation, and efficient in consumption of current to warrant their use commercially, marks one of the most important steps in the advancement of production and distribution of power supply which the last century afforded. Prior to the results achieved by Mr. Sprague, electric motors had been made, not only in the United States, but elsewhere, which were capable of operating machinery and driving line shafts. The state of perfection to which they had been brought, however, was not such as to warrant the investment of any large amount of capital in exploiting their manufacture, and their shortcomings were so great as to prevent their extensive installation as a means of driving machine tools or distributing motive power on a commercial basis.

The progress which has been attained since the year named, in the improvement of design and construction of all classes of motors, can hardly be appreciated by one who has not been intimately in touch with the subject. Suffice it to say that under Mr. Sprague's vigorous leadership, capital was rapidly attracted to the manufacture and marketing of these machines, and their uses in all classes of mechanical industries spread with a marvelous degree of rapidity.



A SPRAGUE MOTOR OF 2 HORSE POWER, EARLY TYPE.
This is a somewhat later form than the one shown on the preceding page.

The advance within the last ten years has been even more remarkable, and one can hardly mention any piece of apparatus of the size and weight, or sold for the price, which embodies the results of more painstaking work on the part of designing engineers, and the expenditure of more money on experimental account, than the small motor of the present day. Every individual part or piece of the modern, high-class, small electric motor represents the combined results of years of thought and experimental work.

A great number of drum windings have been developed and tried. The old ring winding and the shuttle winding are practically things of the past. Surface-wound armatures have given place to iron-clad or toothed armatures, and solid poles to laminated poles. Shunt-wound motors, as supplied by the leading manufacturers, approach very nearly to their theoretical possibilities, and the design of compound-wound motors may be so varied as to meet practically any requirements. The multipolar motor has been developed to a high state of perfection, and hardly any motor is considered marketable today which is not of the enclosed type. Commutators have been largely improved, both in material and construction, and carbon brushes have entirely replaced those of copper. Efficiency, too, has been vastly increased so that, according to size, from 75 to 90 per cent. or more of the energy supplied to the terminals of the motor is easily realized in brake horse power at the pulley.

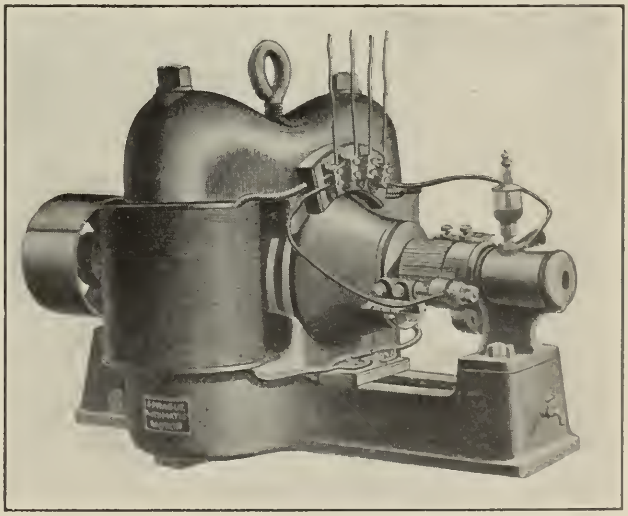
The central stations of many cities and towns, having reached the territorial limits in profitable distribution of power by direct current, have within the past two years been re-arranging their lines, adding single, two-, or three-phase circuits, and now, more than ever before, are finding uses for small alternating-current motors.

The so-called "zone system," much used in Europe, is now being widely adopted in the United States. This system makes use of two- or three-wire direct-current distribution within a circle varying in radius from one to two miles from the central station, and for outlying territory, single or polyphase alternating-current circuits are made use of. The result of these changes has been to enlarge greatly the field for induction motors, both in replacing machines which were previously operated on the direct-current circuits, formerly extending beyond the present boundaries of the inner zone, and also for the new power business which is being developed in the outer zone.

While there still is, and undoubtedly for many years will be, a large demand for direct-current motors, it seems probable that, relatively, the larger business of the future will be in motors operated from alternating circuits.

The possible users of power now located within reach of the direct-current supply have been pretty thoroughly canvassed and their requirements met. As cities and towns grow, manufacturing naturally gravitates towards the outskirts, owing to the increasing value of real estate in the centers. New industries of a mechanical nature also are more likely to locate in the outer zones than in the inner; hence, the use of alternating - current motors is now, and will be in the near future, at least, of relatively rapid growth.

With the improvements recently made in these induction motors, their use has rapidly extended and they are now



5-HORSE-POWER SPRAGUE MOTOR. AN EARLY TYPE.

Later in date of its appearance than the one illustrated on the page opposite.

A MODERN DIRECT-CURRENT I-HORSE-POWER MOTOR WITH TERMINAL COVERS.

General Electric Co.

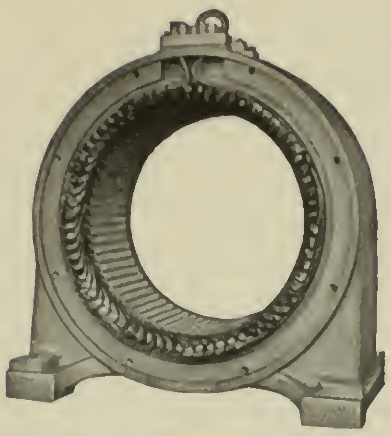
employed for nearly all purposes to which direct-current motors have been heretofore applied. In fact, the only real limitation to their use, in nearly all applications, arises from the difficulty of obtaining variation of speed. This can be accomplished, but it is a matter of some considerable expense and the results are not so satisfactory as in case of direct-current motors.

As motors have improved in quality and have been purchasable at lower prices, and central stations have multiplied over the country, distribution systems have been extended, and the cost of operating motors lessened, until they have come into such common use that the small steam engine is seriously threatened, and various oil and gas engines as well.

When one considers the enormous amount of power generated and distributed for manufacturing purposes in the United States, and then remembers that probably less than 7 per cent. of all this power is distributed electrically, he can begin to form some idea of the vast possibilities yet unrealized in the use of electrical motors. It is estimated that there are at the present time not less than 60,000 motors in daily operation in America, exclusive of those used for railways, automobiles, fans, and elevators, and these 60,000 motors—which represent an investment of about $12,000,000—are supplying something like 1,000,000 horse power. Among the more urgent reasons for the adoption of electrical distribution of power and motor drive are:

Increased production due to possibility of almost perfect maintenance and regulation of speed; saving in power supply; saving in floor space required for producing a given output; flexibility of machine location with regard to light, sequence of operations carried on, and ease of supplying the raw material and removing the finished product; elimination of dust and dirt; safety to operatives; ease and facility of adding to the existing equipment; ability to work individual machines overtime without wasting more power in operating line shafts than is consumed by the machine operated; independence of operation in each machine, i. e., freedom from a complete shut-down if a main shaft or

5-HORSE-POWER MOTOR MADE BY NORTHERN ELECTRICAL MFG. CO., MADISON, WIS.
1950 revolutions, 8.75 amperes, 500 volts, direct current.



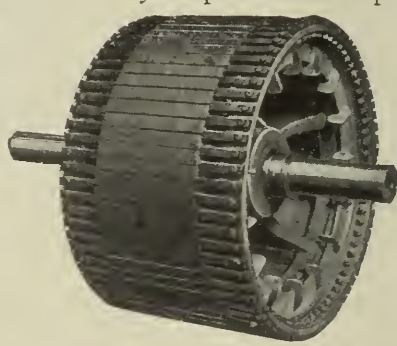
CONSTRUCTION OF A WESTINGHOUSE POLYPHASE INDUCTION MOTOR. THE PRIMARY COMPLETELY WOUND.

belt gives out; possibility of lighter roof structures—no heavy shafts and belts having to be supported—and consequent decrease in cost of building.

These are only a few of the many good and sufficient reasons for adopting electric drives. It is hardly necessary to elaborate on this point further, what has been said being fully suggestive to one studying the subject carefully.

There is no problem of more vital interest to the small manufacturer, repair-shop man, or user of light machinery, than that of obtaining a cheap, reliable, simple, and continuous source of power. This question is often the dominating factor in determining the location of a shop or manufactory. Nearly everything else is subservient to it. There are throughout the United States thousands of mechanics and manufacturers using light machinery, who are quartered in out-of-the-way, low-studded, badly ventilated and badly lighted shops, for the reason that it is only in such locations that they can find shafting to which they can attach their machines and from which they can obtain the necessary power to operate them at a reasonable cost.

Aside from the prejudicial effects to health and eyesight arising from working in such unhygienic surroundings, they are a positive and serious detriment to a man's business success. People do not like to enter gloomy, out-of-the-way, ill ventilated and dirty shops to place their orders or to look for such articles as they may be in search of. A pleasant, well lighted and well ventilated, easily accessible store or factory is an absolute necessity to any man desirous of making the most of his business. Even if a room be clean, light, and well ventilated at the start, it soon becomes gloomy and dirty if power is supplied to its occupant from the time-honored line shaft with its attendant heavy belts, frictional electricity, constant dust, and dropping oil.

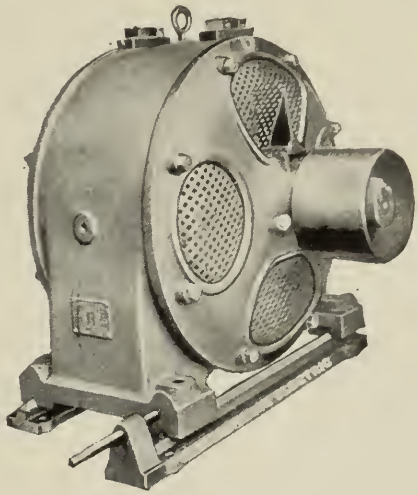


SECONDARY COMPLETE.

With the advent of the electric motor, the necessity of putting up with these conditions is largely eliminated. In all principal cities and towns, there are electric stations from which a supply of electricity may be readily obtained for operating motors. In the same cities are many well-lighted, well-ventilated, easily accessible locations for small shops or factories which could be rented at a low price and which would serve admirably as locations for small mechanics and manufacturers, did they posses the one vital element of power supply.

The electric motor enables one to locate his factory or shop wherever he desires, and by its use to have at command a continuous, clean power service available in many cases twenty-four hours per day.

With the electric motor deriving its current from a central station which supplies perhaps hundreds of customers, there is a great deal of flexibility in the matter of power supply. All of the consumers are never using the maximum at the same time; hence the station is not obliged to maintain, relatively, so large and expensive a reserve, to be paid for pro rata by its customers, as is the landlord of a building. The so-called "diversity factor" is more largely availed of. Electricity for operating the motor may be supplied through a meter which is a reliable register of energy consumed, and is as accurate as any piece of apparatus of similar nature can be. When the switch governing the motor is closed, the current immediately begins to flow, but the motor, being an automatic mechanism, takes current only in proportion to the amount of work it is doing; hence, the meter connected with it will record a charge proportional to the work actually being done.



WESTINGHOUSE TYPE "C" POLYPHASE INDUCTION MOTOR, COMPLETE.

As an illustration, take the case of a circular saw. Ordinarily a mechanic has to pay his landlord for power to nearly the full rating of the saw—say five horse power. If his business is such that he always saws hard-wood planks three inches thick, we will say, and is doing it ten hours per day constantly, then the charge which he pays is reasonable and just; but if his business is of such a nature that he only occasionally saws such a plank, more often saws half-inch pine, and perhaps for hours has his saw remaining idle, then in the case of steam he is usually paying a sum largely in excess of what he ought to pay. If his saw was driven by an electric motor, current would be charged for at the five-horse-power rate only while he was doing the heavy work. When he was doing the light work the meter would charge up current at perhaps only one-half of one horse power, and when the saw was still, absolutely nothing would be charged up. The same argument in favor of the electric motor applies to all classes of machinery—lathes, planers, die and printing presses, sewing machines, paint mills, buff wheels, metal rollers, paper cutters, and the thousand-and-one different types of machines which are to be found among the various small shops and factories.

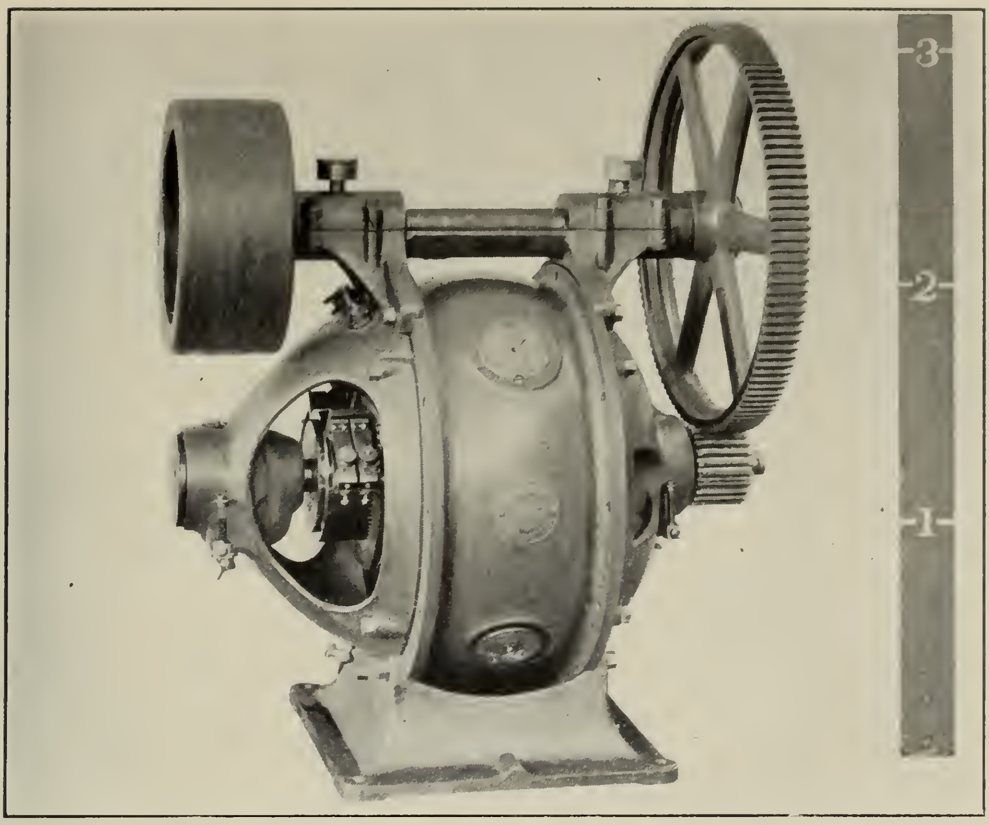
It is immaterial whether the tenant hires a room on the first, second, or third floor, or in the basement; one place is just as accessible for power as another, for wires may be run anywhere, and extension shafts, mule pulleys, skew belts, and other like power-wasting devices are avoided.

Again, each tenant in a building supplied with steam power is absolutely dependent, so far as his own power is concerned, on the operation of one engine with its attendant main shafts and belts. If any of them give out, then every tenant must stop work until repairs can be made. In the case of motor-driven machinery, the problem is entirely different. Stations are equipped with duplicate and even triplicate machinery, and a combination of circumstances is scarcely conceivable, which will deprive the customer of current; in fact, investigation will show that motors driven from central stations furnish the most reliable power obtainable.

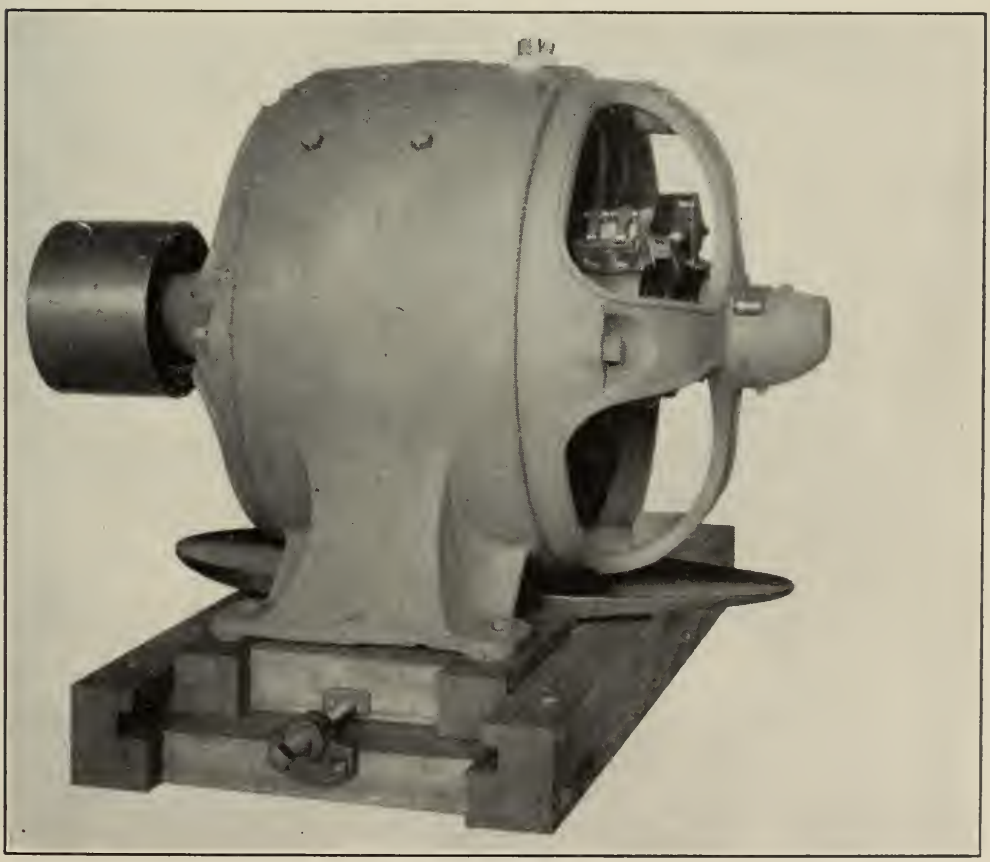
In the present day of keen competition it is necessary for tradespeople to take every advantage possible in promoting their business. The location of their warerooms or factories must be on the path of travel and easily accessible; every item of expenditure must be carefully gauged, and they must rid themselves of any charges for power or rent which are not absolutely necessary.

Central stations are, as a rule, very moderate in their charges for connecting motors to their circuits. They will run wires any reasonable distance, and will make a meter rate which is very attractive. In any event, the buyer of electric power knows to a certainty that he is paying only for power he actually uses from minute to minute, and that the size of his power bill is in his own hands. If he is careful to shut down his machinery when it is not in use, he can limit his expenses in this regard to the absolute cost of power required while the work is on the machine.

When power is supplied to machinery from an engine, it is very difficult to ascertain whether the machinery is working at its best or not, and whether there are any undue friction loads developing. If



6¼-HORSE-POWER, 230-VOLT, BACK-GEARED MOTOR.
The Jenney Electric Mfg. Company, Indianapolis.



MODERN TYPE 5-HORSE-POWER MOTOR MADE BY THE GENERAL ELECTRIC COMPANY.

GROUP OF SMALL ALTERNATING-CURRENT MOTORS WITH STARTING COMPENSATOR-CONDENSERS.

General Electric Company.

a motor is driving machinery, however, it is very easy to determine from time to time the amount of power consumed when the machines are running light, and if this amount shows a perceptible increase, it indicates at once that there is undue friction which can be easily located and the necessary remedy applied. This, in itself, is a very valuable feature of electric driving as it often discovers, especially in shops running on piece work, the abuse of lathes, screw machines, etc., by the piece workers having care of them.

The flexibility of a motor system is also of the greatest advantage. There is hardly a shop where frequent changes are not made either by putting in additional machinery, or changing the location of the existing machines. When such machines are driven by motors, it is far easier to change the wire circuits supplying them than to change a line of shafting with its attendant pulleys and belts. Furthermore, in engine-driven factories the entire location and lay-out has to be dependent upon the relative accessibility to, and location of, the driving shafting. This often results in the necessity of arranging the machines most disadvantageously, so far as strict regard to the sequence of operations to be carried on is concerned. Motor-driven machines, on the contrary, may be located to the utmost advantage in relation to the general layout of the factory and without regard to a line shaft. As motors may be attached to the wall or ceiling, the belts may be short and the pulleys light, causing a material saving in floor and ceiling space.

The final results of all these desirable features of electric driving and the use of motors are increased output, lower cost, higher quality of product, and larger profits.

FOUNDRY MANAGEMENT IN THE NEW CENTURY.

By Robert Buchanan.

V.—THE CUPOLA AND ITS MANAGEMENT.

Mr. Buchanan's first article appeared in our issue for December, and dealt with the general arrangement of the foundry, heating and ventilation, and the supply of tools and minor plant. His second paper discussed crane service for the foundry floor; his third, moulding by hand and machine. The discussion last month took up the specification and purchase of supplies. The concluding article, which will appear next month, will review the "Qualities and Training of the Foundry Manager."—THE EDITORS.

AS the cupola is without exception the most important individual part of the foundry plant, a knowledge of its construction and principles of operation is of surpassing importance. The short wide cupola of thirty years ago has largely given place to a cupola of a different type. The height has been increased, and for a given melting capacity the diameter has been lessened. This has been accompanied in most cases by increased pressure of blast. With change of form has come faster melting, and decreased consumption of coke. At the same time the new type makes greater calls upon the intelligence and ability of those controlling and working the cupola. The increased height makes possible a completer use of the heat generated from the coke by utilising it in heating up the charges of iron as they descend the cupola during the process of melting. For this reason the height of every cupola should be as great as may be practicable, the limit being fixed by the facility with which the materials are elevated to the charging platform. Fourteen to fifteen feet between hearth and sill of charging door is a suitable height in most cases.

Whether cupolas be short or tall, the principle on which they melt is the same, the blast blowing onto the fuel, the iron to be melted being a certain given distance above the points of entrance of blast. The form which the cupola shall take in the region of the tuyeres down to the bottom or hearth depends largely on the class of work for which the metal is to be melted. Where light castings are the main production and thorough mixing of the iron in the cupola of no great importance, tuyeres may be fixed at a short distance above the hearth. Such a placing of the tuyeres, however, must be accompanied by ready means of drawing slag from the cupola. Where heavy castings are being manufactured, the tuyeres must be sufficiently high to admit of the collection of a quantity of metal on the hearth of the cupola; by this practice better mixing of the metal is obtained. Proper mixing is not possible in a cupola with low tuyeres, from which the iron is carried away practically as quickly as melted. If it is desired to improve the quality of the iron still further by more thorough mixing, and at the same time have the tuyeres a few inches only above the hearth, then it is necessary to use a receiver, or fore-hearth, in which to collect the metal. This latter method, however, has the drawback of increasing the quantity of coke used on account of the receiver absorbing some of the heat generated from the coke, but under quite conceivable conditions this expenditure of fuel is permissible.

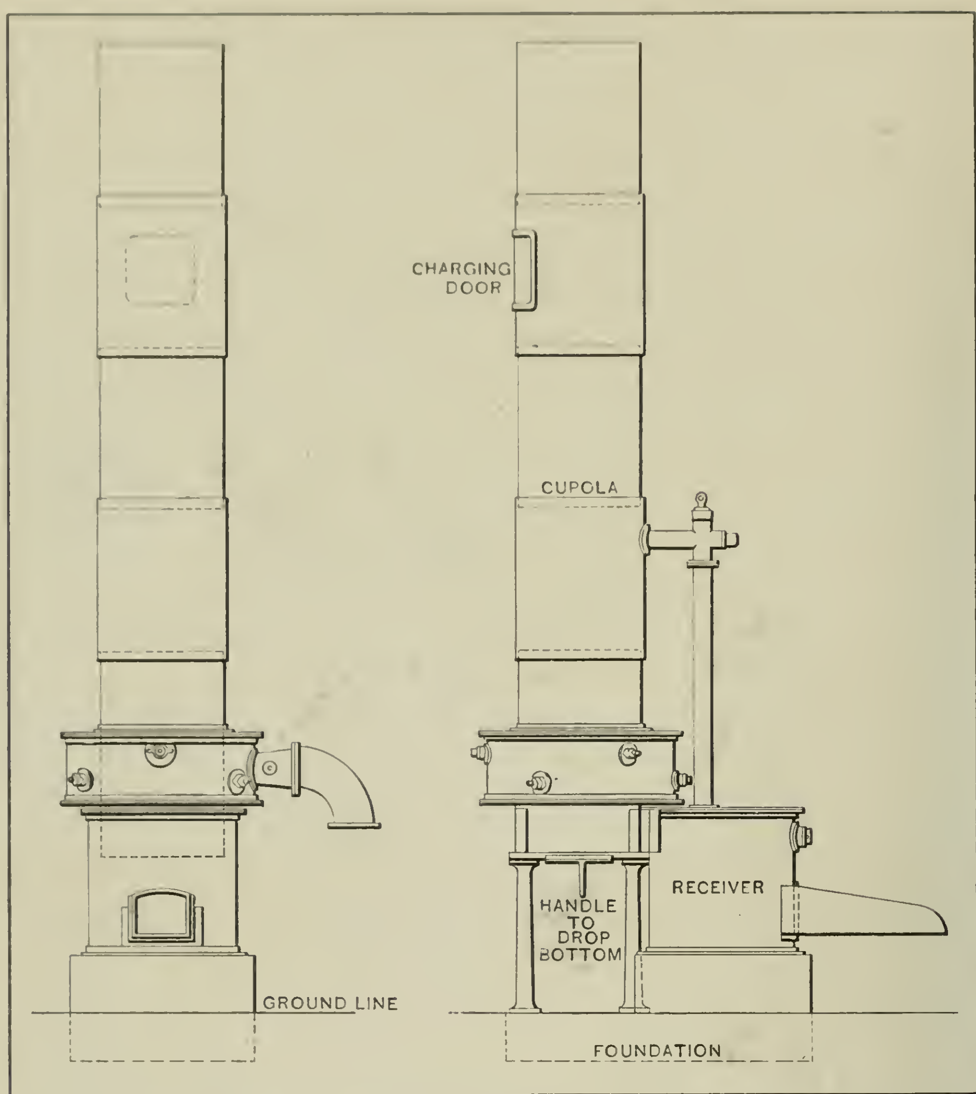
84-INCH COLLIAU CUPOLAS IN RELIANCE FOUNDRY, ALLIS-CHALMERS CO.

Cupolas having solid bottoms are in almost universal use in Great Britain. The drop bottom is even more universally used in the United States. The advantages of the solid bottom are that it requires only one making up, and retains the heat from the previous cast, and so does not chill the iron when melting is first begun. The principal drawback is the awkwardness with which the remaining coke and slag

NEWTEN CUPOLAS, FOUNDRY OF DETROIT SHIP-BUILDING COMPANY.

Bricked-in construction, with charging floor supported entirely by a brick wall. Front tap spout serves large crane in main portion of foundry; side tap spout serves 15-ton crane in "lean-to." Northern Engineering Works, Detroit, Mich.

are withdrawn from the cupola at the termination of the melt. The advantages and disadvantages of the drop bottom are nearly the converse of these. It requires making up each day; chilling of the first iron melted more readily takes place; but the facilities with which access may be had to the cupola, and the readiness with which the contents of the cupola may be withdrawn at the end of the cast, leave a balance of advantage in the use of the drop bottom.



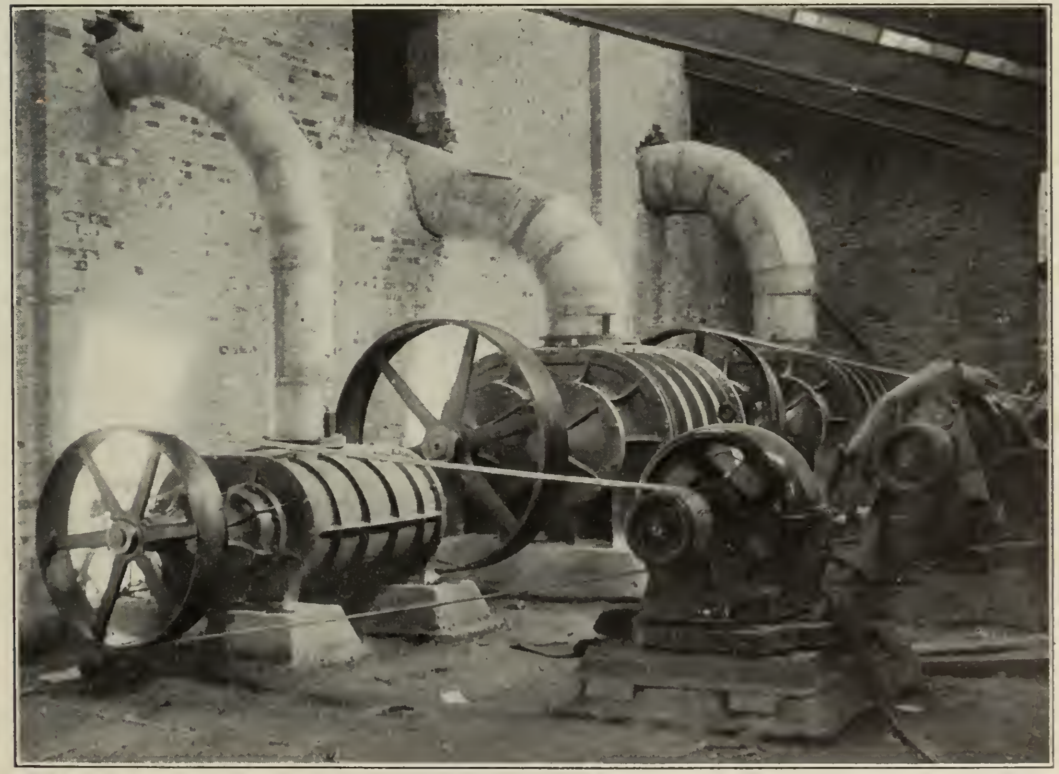
HIGH-SPEED ECONOMIC CUPOLA, CHRISTY & NORRIS, CHELMSFORD, ENGLAND.

Cupola linings are almost invariably of fire bricks or other siliceous material, though Professor Turner mentions that the lining of the cupolas at the Homestead Steelworks, Pittsburg, are of mica stone in the melting zone and sandstone higher up. It is questionable, however, if science has said the last word in regard to cupola linings. The facility with which the oxides of iron combine with silica obtained from fire brick, ganister, or other siliceous material to form a fusible compound, makes it desirable that a lining free from this drawback may be available. That such a material must be neutral is certain, as basic linings have been tried and found wanting.

Coke.—In considering the quality and quantity of coke to be used in the cupola, it is most profitable to use the best quality, as regards high carbon, low sulphur, and ash. These conditions should be accompanied by density of structure. When carbon is low, the highest temperatures are not obtainable unless a greater quantity of coke is charged. This necessitates increased quantities of fluxing materials, and if the sulphur be also high, hardening of the castings is an inevitable result.

A prejudice exists against coke made in patent ovens, such as the Simon-Carve, where the bye-products are recovered. I have used hundreds of tons of this coke and consider it equal to bee-hive oven coke in everything but appearance.

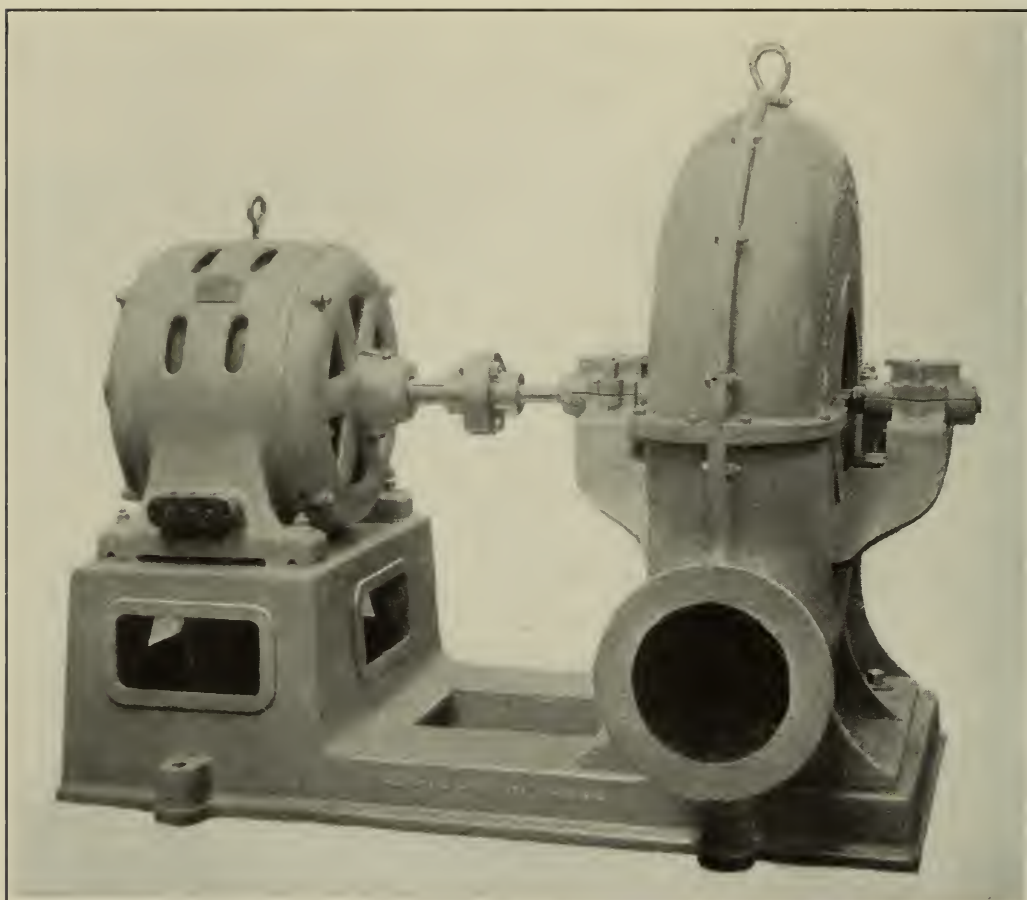
In comparing one foundry with another regarding the consumption of coke per ton of metal melted, it is well to bring into consideration the quality of the iron melted. It is misleading to compare the melting of iron high in phosphorus with the melting of low-phosphorus iron, owing to the facility with which the former may be brought to a very fluid condition. Low-phosphorus iron always requires a greater quantity of fuel to melt it, the quantity increasing as the percentage of phosphorus decreases. It is important to keep a thorough record of the consumption of coke, and to have a means of checking the records so that the best results may be obtained at the cupola. These, and the records relating to the charges of iron going into the cupola, are worse



BLOWER ROOM IN WEST ALLIS FOUNDRY, ALLIS-CHALMERS CO.

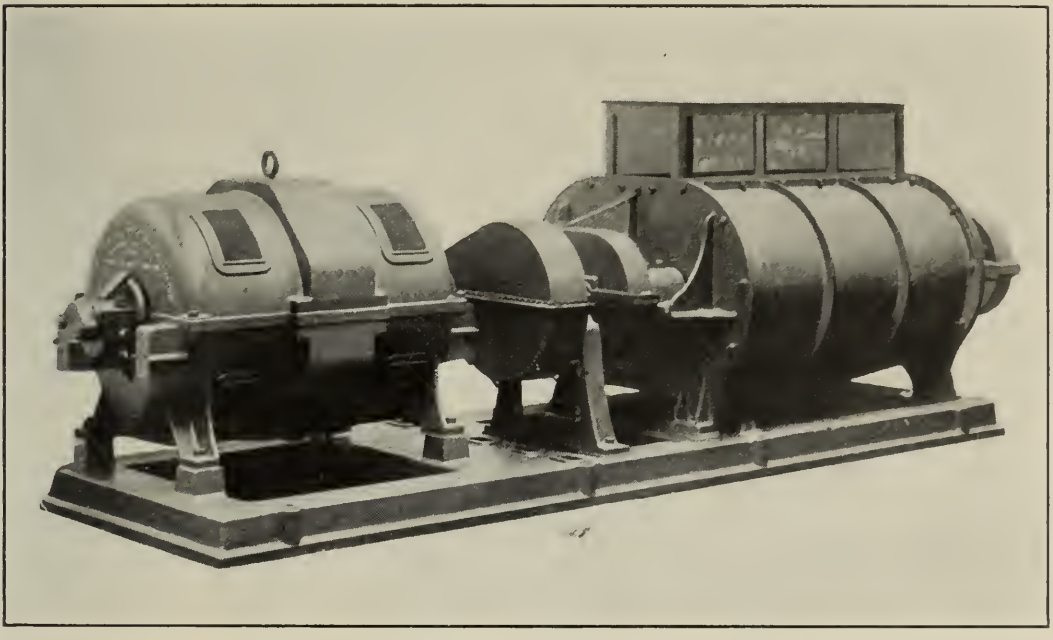
than useless if not accurate. Should there be no records, or no checking of records where they exist, melting is sure to be costly and mixing not well done. Be not over-anxious to save coke. The great consideration is to produce metal suited for the work to be cast. If that is not being done then saving coke is not economy. Almost all wonderful records in melting are merely got up as records. If during a year's work one has been melting from 7½ to 8 pounds of iron with 1 pound of coke, then it may be considered satisfactory.

Some years ago cupola mixtures were almost wholly made up by the manager or foreman from brands of iron which were known to him by experience or reputation. This way of mixing is not by any means extinct yet, but happily its days are numbered. We have now come to a time when more exact knowledge is available regarding the quality, nature, and effect of irons possessing certain characteristics, and these may be enlisted so as to form a fairly definite compound. It is in the nature of things that the foundryman who contents himself with the weapons of fifty years ago should be at the mercy of the



MOTOR-DRIVEN CUPOLA FAN, ALLDAYS & ONIONS, BIRMINGHAM, ENGLAND.

competitor who can bring to his aid the science and knowledge of to-day. If one would use the newer aids to accurate and economical working, he must know, so far as the science of the time has reached, the effect of the various constituents to be found in iron and how they affect the quality of the iron. It is not possible with the space available to give any extended notice to this aspect of the question, but briefly to indicate the outstanding features.

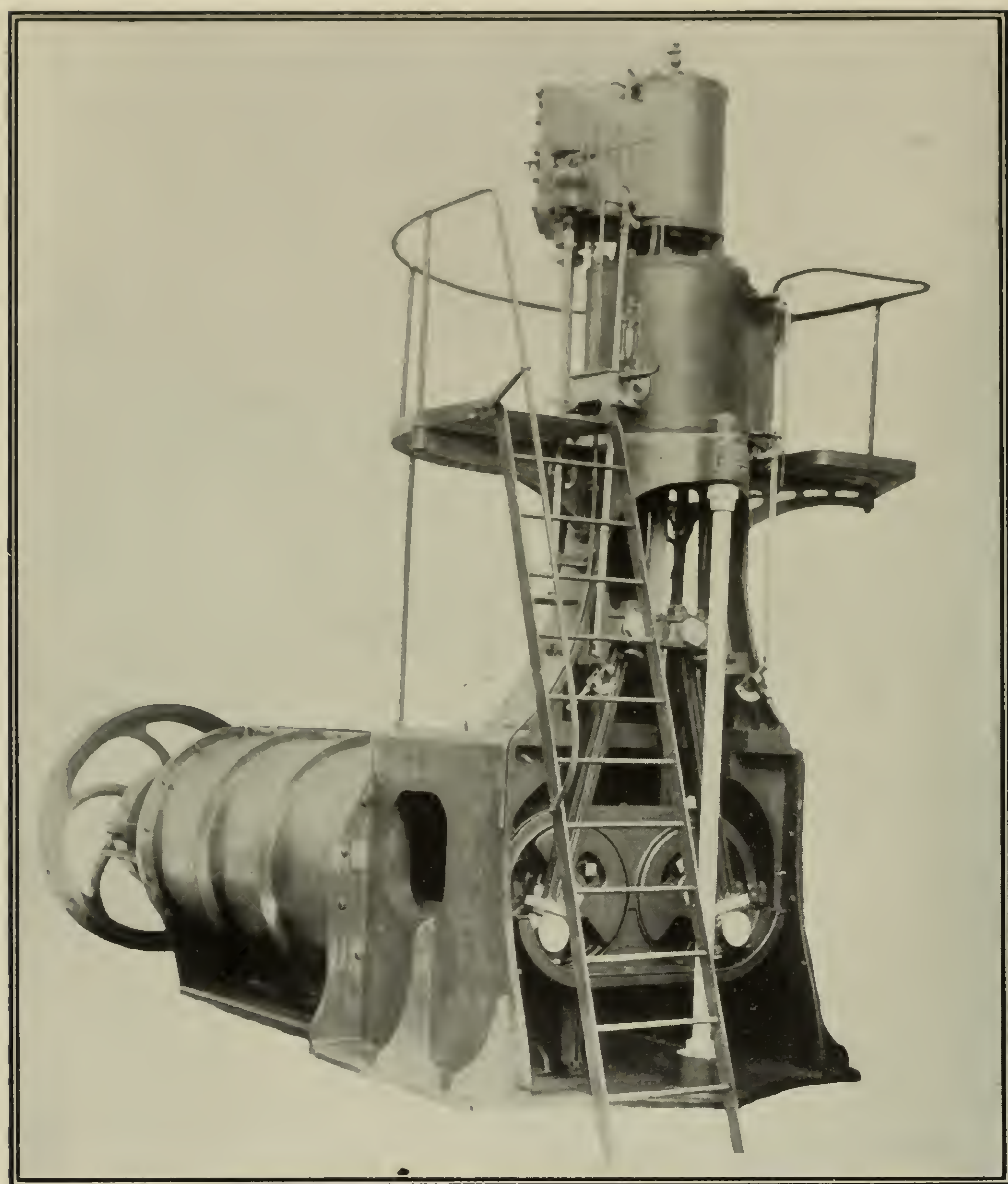


ELECTRIC-DRIVEN ROOT BLOWER FOR CUPOLA BLAST. SAMUELSON & CO., BANBURY.

In making up mixtures of iron it is necessary to bear in mind the class of castings for which the metal is intended. If light castings are the class being manufactured, and appearance rather than strength is desired, then phosphorus may reach as high as 1.5 per cent. When phosphorus is under 0.80 per cent. the metal is less fluid and does not give such a fine skin to the casting. Such a casting will sustain shock much better than one with higher percentages of phosphorus. Silicon may be over 3 per cent. and should not be under 2.4 per cent. Sulphur should not exceed 0.10 per cent. in the casting. Manganese may reach 1 per cent. and total carbon should be the highest obtainable. Irons which are high in silicon almost invarably have low sulphur and low total carbon.

In castings 1 to 1½ inches in thickness which are to have strength and good working qualities, silicon may run to 2 per cent., phosphorus 0.40 per cent., sulphur 0.10 per cent., manganese up to 1 per cent., combined carbon 0.4 to 0.5 per cent., the remainder being graphitic carbon.

For heavy castings of the highest quality, silicon may be 1.20 per



ROOT BLOWER DIRECT-COUPLED TO COMPOUND ENGINE.
Samuelson & Co., Ltd., Banbury, England.

cent., phosphorus 0.20 per cent., sulphur not exceeding 0.10 per cent., manganese up to 1 per cent., combined carbon 0.60 per cent., the remainder being graphitic carbon.

To obtain these percentages, the analysis of the various pig irons forming the mixture must be available. These, with the scrap, may be combined in such proportions as to give almost any necessary result. It is to be noted that however well metal may be mixed, either in charging into the cupola or afterwards when melted, certain changes have taken place in the course of melting which must be taken into account. In the course of one melting, silicon will decrease by about 0.25 per cent., manganese decrease by 0.10 per cent., and sulphur increase by 0.038 per cent. Phosphorus usually remains unchanged by melting. If any change does take place it is by increase, as the blast oxidises iron more readily than phosphorus.

Whether total carbon be increased or decreased in the course of melting depends largely on the amount of coke used in the cupola. When the coke is down to a fine point, simply doing its work and no more, there is a great likelihood of the blast oxidising the carbon in the iron (and sometimes the iron itself) to a considerable degree. Under such conditions, the carbon is decreased. On the other hand, full charges of coke take up in a greater degree the oxygen of the blast, and so the carbon of the iron, and the iron itself, are less subject to oxidation. Under these conditions it is quite possible to have an increase of total carbon in the castings produced. It may be noted that silicon and manganese are still more readily oxidised than the carbon present in the iron.

It is important to remember that hot melting and hot pouring give the best results in quality of iron. The difference in strength of two test bars of similar area, one cast hot the other cast dull, may be as much as 12.79 per cent.* A high temperature in the cupola has the effect not only of making fluid iron, but also of making fluid slag. The high temperature and fluidity of the slag increases its capacity for absorbing sulphur. Such an affinity does not obtain when the temperature is low, a "low" temperature meaning one which produces melted iron of a heat not higher than the "red molten" condition. At such a temperature the affinity of the slag for sulphur is less than that of iron at a similar temperature, and so the sulphur of the coke almost certainly goes into the iron with disastrous results to the product. If the slag and iron be allowed to cool in contact, not only will the iron retain the sulphur it originally had, but it will absorb the greater part of the sulphur present in the slag. Hot melting, and ladles free from slag, are thus of prime importance.

The following points regarding cupola condition and management may be worth noting:

Double rows of tuyeres deepen the melting zone, and increase the speed of melting. If three rows of tuyeres be used the upper row rapidly wastes the lining. The combined area of the tuyeres should not exceed one-tenth the area of the cupola at the melting zone. As the area of the cupola increases so should the blast pressure, that the

* See "The False Witness of the Test Bar," The Engineering Magazine, May, 1902.

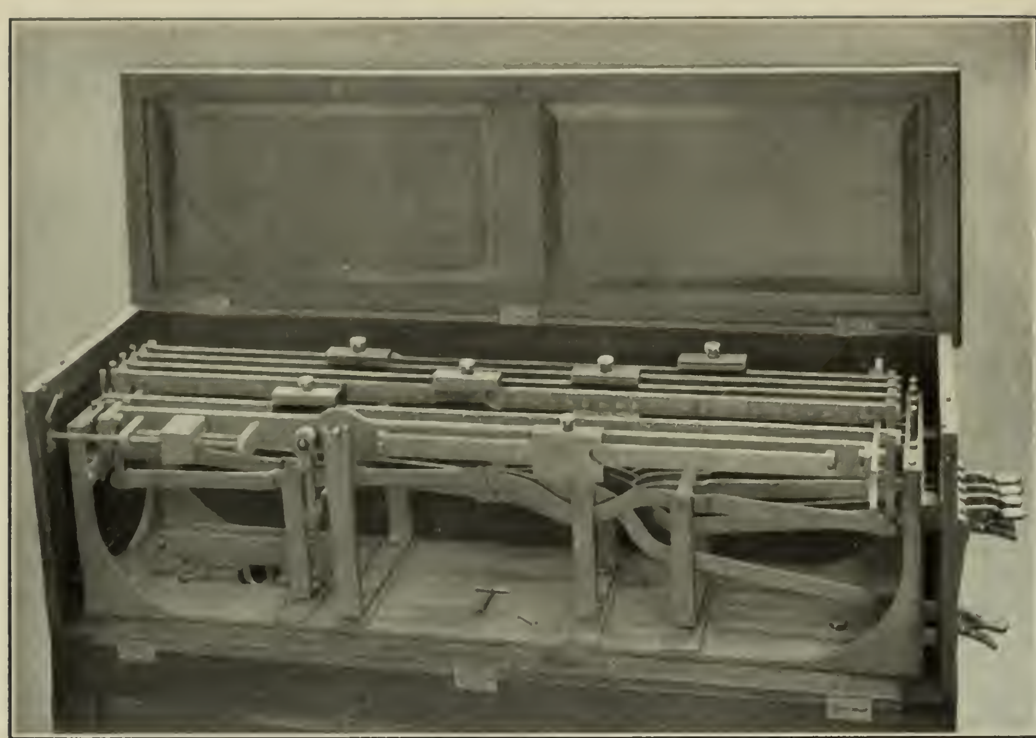
cupola may melt at the centre, as well as in the region immediately over each tuyere. Sloping the tuyeres downwards has no advantage unless it be that if they fill with slag or iron they will empty themselves into the cupola at next tapping. Tuyeres which fill with either slag or iron prove bad design or bad management. If the coke is soft, decrease the pressure of blast and increase the tuyere area. If the coke is dense and hard, use high-pressure blast. Twelve to sixteen-ounce blast may be considered high pressure in ordinary foundry practice. Four to six-ounce is low pressure, and will melt hot though slowly. When using high-pressure blast, the bed of coke should extend from 18 inches to 24 inches above the highest tuyere. Using low-pressure blast, if the bed of coke be 12 inches over the upper tuyere, that is enough. The wear of the lining at the melting zone will indicate the height the bed should be. Melting takes place in a definite part of the

LOWER END OF SKIP INCLINE FOR CUPOLA-CHARGING APPARATUS, WEST ALLIS FOUNDRY OF ALLIS-CHALMERS COMPANY.

cupola which we call the melting zone. Iron melts there and there only. The melting zone seldom exceeds 36 inches above the highest tuyere. Coke in excess of the quantity necessary for a bed the proper height is simply burnt away without doing any melting. Coke between the charges of iron should just be sufficient to replace that part of the bed consumed in melting the previous charge of iron. The bed is thus kept regular in height, and the melting is regular both in speed and temperature. If the charges of coke are too great the flame from the

HYDRAULIC CUPOLA HOIST, R. D. WOOD & CO., PHILADELPHIA.

cupola is a whitish-yellow colour, wreathing in "oily" folds as it stretches up and out of the cupola stack. The proper flame, if flame there be, ought to be a bluish-pink colour, and have a ragged and torn appearance, as it clings to every projection about the charging door. The heat at the charging door should not be greater than a dark red. A black heat is better still. When lighting up the cupola see it is not lit too early. It requires to be kindled to the top of the tuyeres; every minute after that is reached and blowing not begun, fuel is wasting.



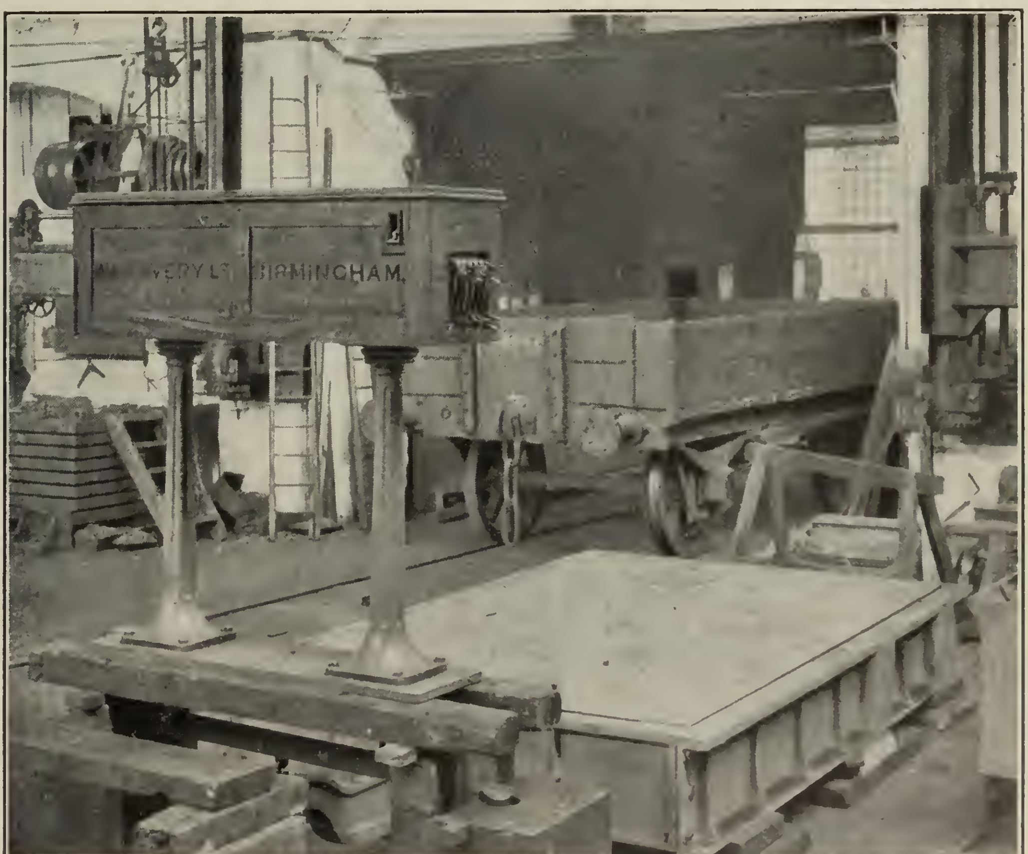
WEIGHING MACHINE FOR SECRET CHARGING OF THE CUPOLA.

One steelyard is used for taring the barrow or other vehicle; the other five, or any number of them, may be used for the several irons forming the charge. The poise on each steelyard is adjusted by the one responsible for the mixture, and the enclosing box is then locked as shown on page 61. Charging is thus both secret and accurate.
W. & T. Avery, Ltd., Birmingham.

Do not keep the cupola standing charged for one or two hours. At kindling time when the fire is at the top of the tuyeres, charge up to the charging door, then begin to blow.

Pig iron high in silicon is now used in many foundries for the purpose of controlling the condition of the carbon in the castings. Silicon has the power to prevent the carbon in cast iron taking the combined or hardening form, by causing it to take the form of graphite. Silicon, if present in cast iron to the extent of 5 per cent. or over, has also the power to diminish largely the absorbent capacity of iron for carbon, and this increases with the increased percentage of silicon. Thus high-silicon irons are always low in total carbon. In this respect silicon and manganese differ, manganese increasing the capacity of iron to absorb carbon. Silicon also tends to neutralise sulphur present in cast iron. When Professor Turner of Birmingham University made the important discovery of the influence of silicon on cast iron (a discovery which some who had nothing whatever to do with it seem not disinclined to share with him), many foundrymen had the idea that the days when illimitable scrap could be made into soft castings had come. This proved a disappointment to many, and the reason for this is perceivable in the light of later knowledge. Scrap iron is often rusty, and so its oxides tend to lessen the total carbon, and as siliceous pig iron is also low in total carbon, the resulting metal tends to cause drawing or sinking in the castings. While the excessive use of scrap is not advisable for the reason given, the knowledge of how and to what extent softeners may be used is valuable. Silvery or "silky" iron may often be bought at prices under those of ordinary No. 3 iron. This "silky" iron has sometimes as much as 5 per cent. of silicon, and is used to bring to a proper average the silicon contents of scrap or pig iron low in that element. Thus by using three cheap irons, each of an off grade or low number, excellent iron may be produced.

The use of steel scrap for the purpose of strengthening cast iron is favoured by many foundrymen. That steel will strengthen some mixtures of iron is true; that it will strengthen all qualities of iron is not true, neither does it strengthen any mixture in the way it is too often supposed to do. There is an idea that the addition to cast iron of such a strong material as steel imparts to the mixture some of the qualities of steel. When one considers, however, that steel is a metal whose



WEIGHING MACHINE FOR SECRET WEIGHING, LOCKED UP AND READY FOR USE.

qualities arise from the very definite percentages of iron and carbon forming the alloy, it follows that with a variation of composition, such as is found in cast iron, a very different material is formed. If steel had the strengthening effect which many believe it to have, then it would strengthen all mixtures of cast iron; but this we know it does not. Let us take 900 pounds of pig iron of a certain analysis and add to it 100 pounds of "mild" steel. The percentage composition will be:

	Pig Iron	Mild Steel
Silicon	2.333	0.047
Phosphorus	.413	0.035
Sulphur	.040	0.034
Manganese	.462	0.360
Comb. Carbon	.420	0.211
Graphitic Carbon	3.180	——
Iron	93.152	99.313
	100.000	100.000

The percentages in the mixture are as follows:

	Silicon.	Phos.	Sulphur.	Mang.	Comb. C.	Gr. C.	Iron.
Before melting....	2.104	0.375	0.039	0.451	0.399	2.862	93.768
Changes during Melting — Gain....	——	——	0.038	——	0.100	——	——
Changes during Melting — Loss.....	0.250	——	——	0.100	——	0.100	——
After melting	1.854	0.375	0.077	0.351	0.499	2.762	——

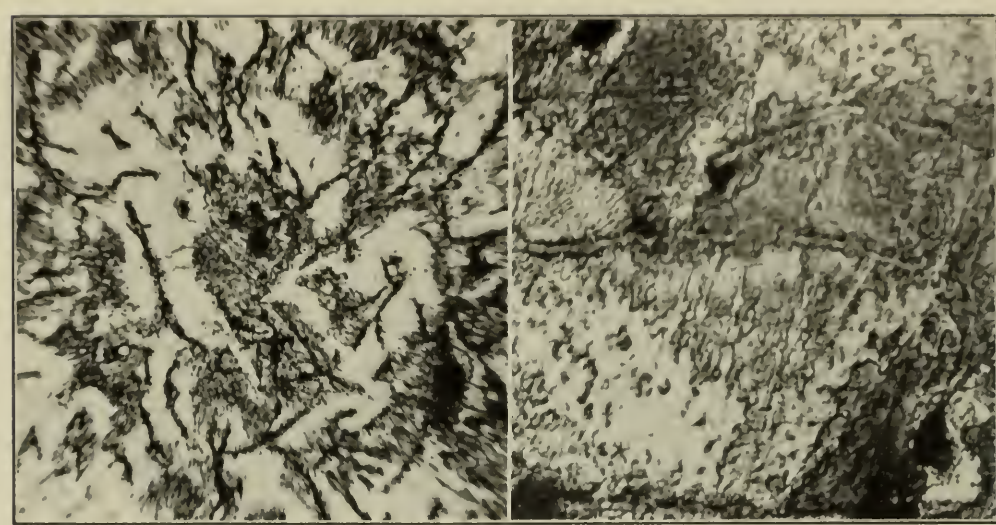
For 1,000 pounds of such a mixture put into the cupola not more than 920 pounds would reach the ladle. The gain in sulphur is such as results from using coke with 0.77 per cent. of sulphur and the combined carbon is increased by 0.10 per cent. because of increase of sulphur and decrease of silicon. To those who understand proper methods of mixing and have a variety of irons to choose from, it is not difficult to produce, solely by the use of cast iron, results superior to those obtained by such a use of steel scrap. Such a mixture as that just shown is easily reproduced without using steel, and the drawbacks attaching to the use of steel are avoided.

THE CRUCIBLE FURNACE IN WHICH PROF. TURNER MADE HIS DISCOVERY OF THE INFLUENCE OF SILICON ON CAST IRON.

THOMAS TURNER, M. S., A. R. S. M. PROFESSOR OF METALLURGY AT THE UNIVERSITY OF BIRMINGHAM, ENGLAND.

Discoverer of the influence of silicon in cast iron.

Where irons are high in silicon and graphitic carbon, steel may be used to lessen silicon and so increase the combined carbon. In this way only does steel strengthen cast iron. When steel is charged into the cupola along with cast iron, how much of the steel reaches the ladle is always a doubtful question, owing to the excessive oxidation which the steel undergoes during its passage down the cupola. If steel is to be used, the best plan is to have it in a finely divided state, such as punchings or turnings, these being added to some of the metal already in the ladle, the remainder of the iron being tapped on the top of it. Brisk stirring of the metal helps to dissolve the steel. The principal objection to this



MICROGRAPHS OF IRON FROM THE BEAM OF A PUMPING ENGINE CAST BY JAMES WATT.
Left, 100 diameters; right, 500 diameters.

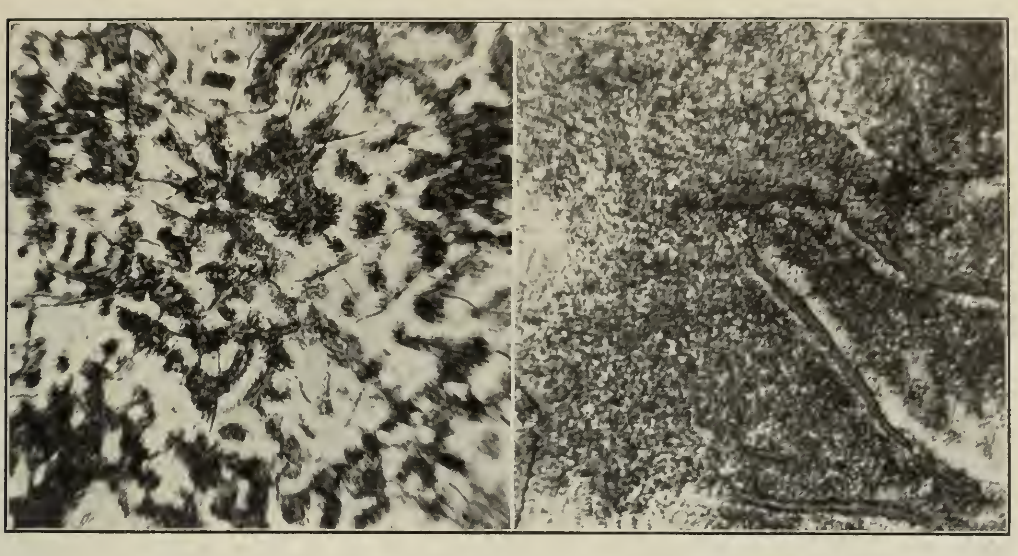
course is the liability of steel not thoroughly absorbed by the iron forming hard spots in the castings.

Physical Structure of Cast Iron.—To shew the physical structure of cast irons of high quality, six photomicrographs illustrating three irons are shown. These have been prepared for the author by Mr. A. E. Tucker, F. I. C., F. C. S., Birmingham, who also has done almost all the detailed analyses in this series. These photomicrographs are prepared by polishing a section of each metal until not a trace of a scratch remains. The section is etched with dilute nitric acid to shew up the structure, and is then photographed while in the microscope. The photomicrograph thus represents to all what the individual eye would see if viewing the section by means of a microscope.*

The first two photomicrographs shew a piece of cast iron magnified 100 times, and the same piece magnified 500 times. That iron was cast by James Watt, more than 100 years ago. It is from the beam of a pumping engine, which worked for nearly 100 years and latterly came back to the Soho foundry as scrap to be remelted. The photomicrographs are accompanied by a chemical analysis, and linked as they are with the historic name of James Watt should prove of considerable interest.

	Analysis. Per cent.		Analysis. Per cent.
Silicon	1.073	Manganese	0.321
Phosphorus	0.658	Combined carbon	0.211
Sulphur	0.082	Graphitic carbon	2.120

* For full details as to the preparation of sections of many kinds of metals and what the etched surfaces convey, see Hiorns' excellent "Manual of Metallurgy" (Macmillan).

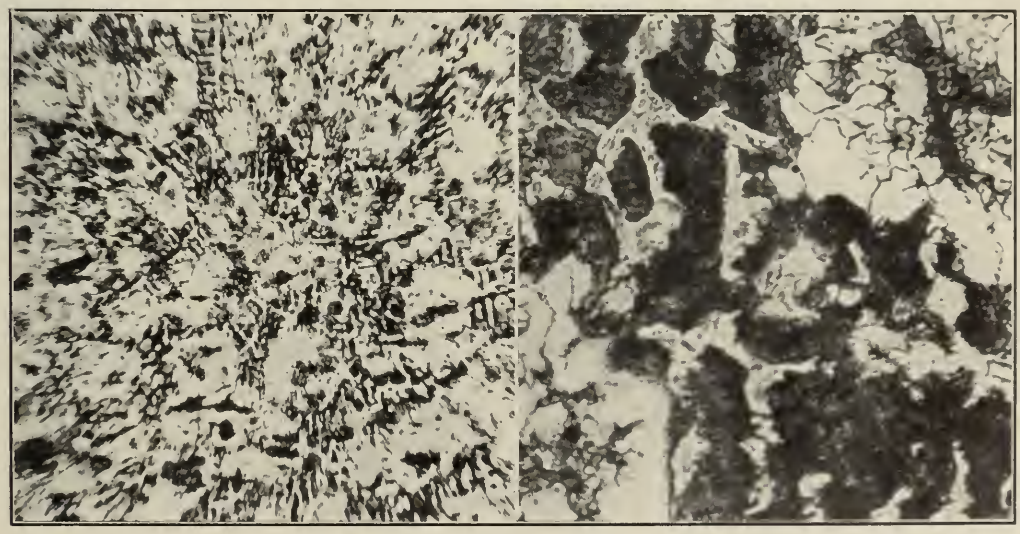


MICROPHOTOGRAPHS OF STRONG CAST IRON, 100 AND 500 DIAMETERS.

The second pair of photomicrographs are those of a strong cast iron of which a test bar 2 inches by 1 inch on supports 36 inches apart had a deflection of over half an inch and fractured at 37½ hundred weight (4200 pounds). This equals 3150 pounds for a test bar 1 inch by 1 inch at centres 12 inches apart.

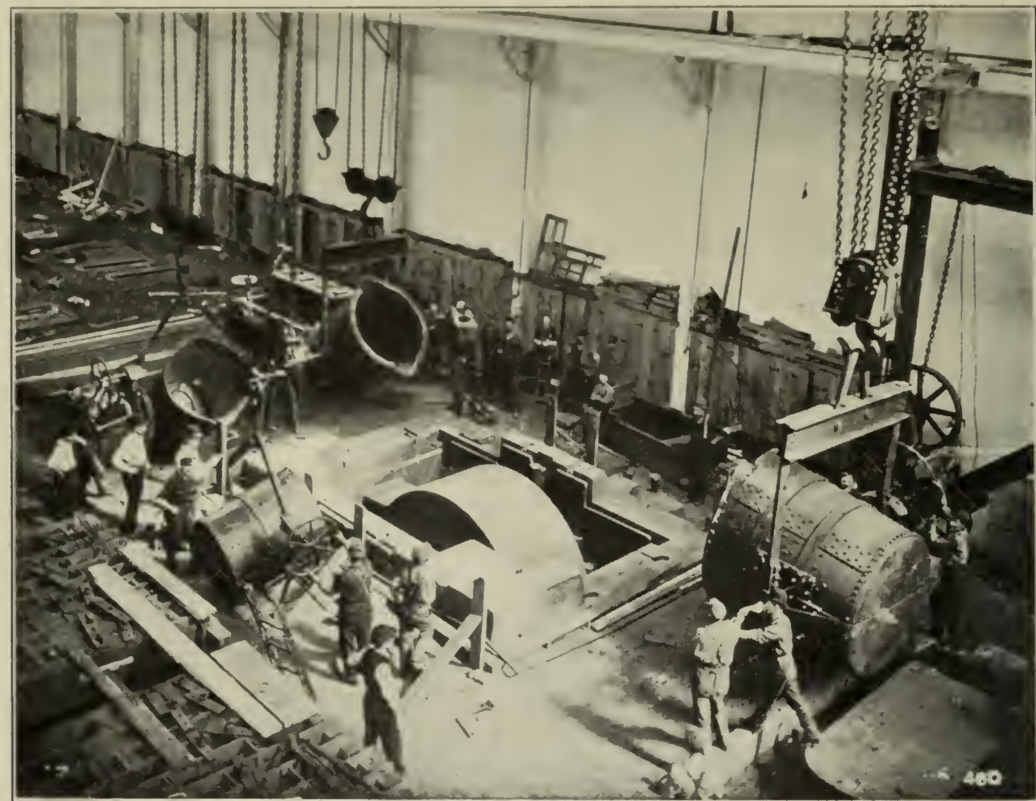
The James Watt iron already shewn formed seven-tenths of the mixture, and it is interesting to observe in the modern iron the reproduction in an accented form of some of the markings to be seen in the older iron. The analysis was:

	Per cent.		Per cent.
Silicon	1.119	Manganese	0.522
Phosphorus	0.692	Combined carbon	0.670
Sulphur	0.108	Graphitic carbon	2.860



MICROPHOTOGRAPHS OF CAST IRON FOR LIGHT CASTINGS, 100 AND 500 DIAMETERS.

The third pair of photomicrograpus shew the structure produced by a first-class mixture for light castings about one-eighth of an inch in thickness. The black splatches in the one magnified 500 times are flakes of graphite and exemplify what makes a casting "soft." When boring or filing has to be done these flakes of graphite act as so many partings betwixt the granules of iron and so assist their separation.



FOUNDRY REHEARSAL, WESTINGHOUSE MACHINE CO. PREPARING FOR POURING A HEAVY CASTING.

Along with the analysis of the soft iron just shewn are given the equivalents of the constituents in pounds and ounces. To emphasise the importance of keeping sulphur low it may be mentioned that were the sulphur increased to 2½ ounces the metal could not be bored.

Analysis of iron in photomicrographs (3)	Per cent.	Weight of constituents in 100 lb. of cast iron as analysis on left. lbs.	oz.
Silicon	2.61	2	9½
Phosphorus	0.79	—	12½
Sulphur	0.09	—	1½
Manganese	0.47	—	7½
Combined carbon	0.19	—	3¼
Graphitic carbon	3.12	3	2
Iron	92.73	92	11¾
	100.00	100	0

Fluxing the Cupola.—Every flux which is used in the cupola has lime as one of its constituents. These fluxes are used for the purpose of combining with the sand or other material which it is desired to keep separate from the metal, and by forming a separate body, which we call slag, this result is obtained more or less successfully. There is a point, however, where an excessive use of lime will cause the slag to decrease in fluidity, but that is not a common occurrence.

Limestone is the flux most commonly used, and is certainly the cheapest unless the circumstances or position of the foundry are of an exceptional kind. Fluor spar, a compound of lime and fluorine, is much recommended as a flux having powerful effects towards reducing the percentages of sulphur and phosphorus in the iron, with a commensurate increase of these elements in the slag. I have made trial as to the powers of fluor spar in this direction, and the results bear out only in a minor degree the claims made in its favour.

Cupola Slags.

	Average of four meltings using 48 pounds limestone per ton of metal melted.		Average of six meltings using 42.8 pounds of mixed limestone and fluor-spar in proportion. Limestone .... 81.50 per cent. Fluor-spar .... 18.50 per cent. (100.00)	
	Per cent.		Per cent.	
Silica	57.23		55.38	
Alumina	9.15		8.40	
Oxide of iron	7.85	(=iron 5.50)	7.97	(iron 6.19)
Lime	22.61		23.20	
Manganese oxide	2.78		4.46	
Sulphur trioxide	0.28		0.45	
Phosphorus pentoxide	0.07		0.11	
	99.97		99.97	

A mixture of limestone and fluor spar was used, as fluor spar by itself is much too expensive. The mixture cost 12 shillings 8 pence per ton as against 6 shillings for limestone. What was gained was an increase in the slag of sulphur trioxide (SO_3) from 0.28 to 0.45 per cent. and of phosphorus pentoxide (P_2O_5) from 0.07 to 0.11 per cent. The increase of sulphur in the slag was about one and one-tenth ounces per 100 pounds of slag—not an inconsiderable amount. As a dephosphoriser fluor spar is a failure. A drawback to the use of fluor spar is the pungent gases coming from it affecting the eyes and lungs of the men about the cupola. What is in its favour is the nicely fluid slag it forms.

Iron Lost in Melting and Handling.—The percentage of "gits" and other returned scrap, including "wasters," has a material bearing, not only upon the cost of production generally, but also upon the amount of iron lost in the course of melting. This percentage will vary according to the class of castings made, and the standard of quality to which the castings must attain. It is thus difficult to say whether a certain percentage of returned scrap is or is not excessive. A foundry making medium to light castings of high quality will have returned

POURING A CROSS-HEAD GUIDE, WESTINGHOUSE MACHINE CO.

scrap, including "wasters," of 24 to 26 per cent. of the weight of good castings made. In a foundry making light castings wholly, the returned scrap may reach 44 per cent. as an average. These percentages are from actual foundry practice. In the latter case the amount of iron lost in melting in the course of a year will be considerably in excess of the other. The loss in melting in a foundry manufacturing a given class of work is no criterion whatever as to the loss which should obtain in other foundries, unless they be engaged in exactly the same class of work. There is great difficulty in ascertaining what the exact loss of iron in any foundry is, including as it does loss in melting and loss as "shot iron." The loss of iron in a foundry making castings of medium size, using "bought in" scrap as part of the mixture, may be taken as running from 8 per cent. to 9 per cent., the scrap naturally causing a greater loss than should obtain in foundries using all pig iron and their own scrap. In foundries making light castings, where the returned scrap reaches, as I have stated, to somewhere about 44 per cent., the loss will be in excess of this, readily reaching to over 11 per cent. To keep the loss in melting to the lowest point possible, see there is proper charging of the cupola with coke, so that the oxidation of the iron by the blast is reduced to the lowest degree possible; proper fluxing, so that the iron combines with the ash of the coke in only the smallest percentages; and proper adjustment of the quantity and pressure of blast. If high pressure of blast be used in cupolas of small diameter, liability to waste in melting is increased. Under no circumstances whatever is it possible to take as much iron out of the cupola as is put in. To test if the loss is normal analyse the slag for oxide of iron. If this reaches 10 per cent. it wants seeing to.

The transport of the metal when it is melted is coming day by day to be considered well worth the attention of foundry men. In foundries doing heavy work, fewer changes have taken place in recent years than have obtained in light foundries. The heavy foundry still depends upon the crane as the means of transport. In these days of responsibility of employers for the supply and use of safe tools, the screw ladle is a factor of safety, leaving out of view altogether the duty of employers to reduce to a minimum the risks of their workmen. No ladle whatever having a capacity of over 10 hundred weight should be without screw gear.

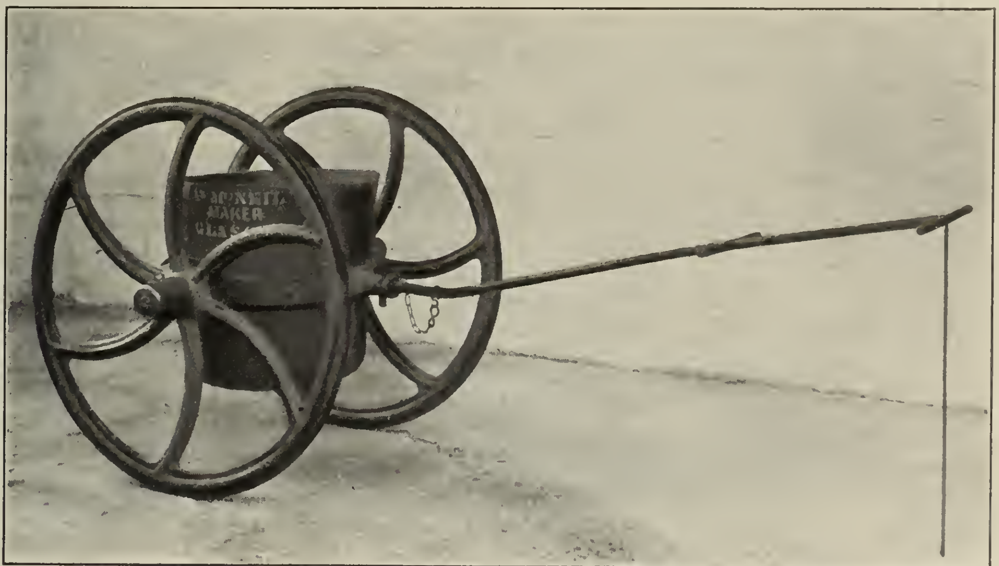
Where foundries are large and moulds are numerous, the trolley or bogie ladle becomes a necessity. Many foundries are adopting in their place ladles suspended from overhead tracks, but it is not every foundry which can afford to have the upper spaces impeded by a trolley track. It is the exception to have a foundry where floor tracks are unsuitable. One cause of objection to trolley ladles running along the floors lies more in the character of the ladles themselves than in the rails or ways along which they run. The desire for ladles which will turn in a small radius in many cases has resulted in ladles being made of dubious stability. Wheels

A BAD TYPE OF TROLLEY LADLE.

LADLE CAR REVOLVED BY SELF-LOCKING CAM GEAR. FOUNDRY OF THE GENERAL ELECTRIC CO.

Height of top above rail, 36 inches. Pours into hand ladle 17 inches high. The ladle moves steadily in the same direction as the handles, but only one-twelfth as fast. Remains locked in any position. Capacity 1,500-3,000 pounds. The C. W. Hunt Co.

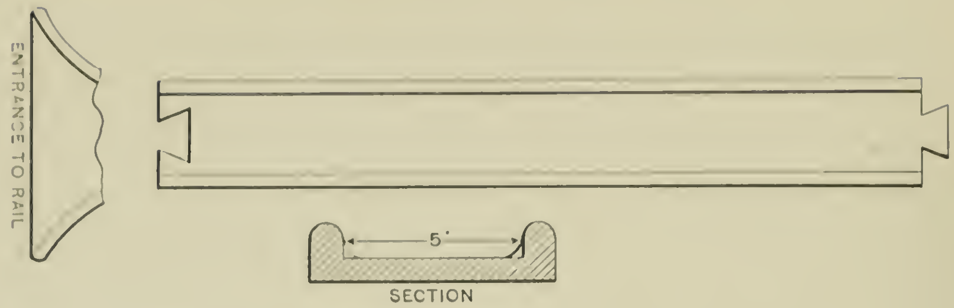
are made of small diameter so that when the ladles are tipped the lip shall not foul the circumference of the wheel. On page 69 is an illustration of a ladle which will turn in a small circle, but it is difficult to draw and is unstable. A very much superior trolley ladle is one mounted between two large wheels, the centre of gravity of the ladle being lower than the centres of the wheels. From the size and form of the wheels these are sometimes called "sulky" ladles. These wheels, being without flanges, run on rails or tracks as shown in the illustration on the next page. This ladle turns in a comparatively small circle, is easily pushed or drawn along, and is absolutely safe. The hand ladles are placed between the rails, pouring being readily done from either lip of the large ladle.



SULKY LADLE MUCH USED IN SCOTCH FOUNDRIES.
Charles McNeil, Jr., Kinning Park Ironworks, Glasgow.

The ladle car shown on the facing page has some very good features, particularly the tipping arrangement, by which the ladle may be left at any angle, without risk of upsetting. The particular arrangement and design, however, necessitates the use of four wheels; this again involves the use of a turn table at all crossings in the foundry, but these are now being widely introduced in connection with the "industrial railway" transport system. The use of trolley ladles has the advantage of reducing the amount of iron poured out by those using hand ladles, as any iron remaining in the hand ladle is poured back into the trolley, and waste is thereby avoided.

Regarding hand ladles themselves, there is little difference between those used in different countries, most of them being made of stamped steel. These are admirable for their lightness, which is an important



RAIL FOR TWO-WHEELED TROLLEY OR "SULKY" LADLE.

feature where much hand-ladle work is done. In some places a short cast-iron body is used, and on the upper part of it is fastened a sheet-iron rim, which is renewed should it get burnt away. Others use the body wholly of cast iron. These are cast bottom upwards, having no top part on the mould, so that should the bottom "blow" or "scab" a little, no harm is done. This has the disadvantage of being heavier than the other two forms mentioned, but has the advantage of being cheaply made, and when burnt through or cracked is melted up again with practically no loss.

Recovery of Shot Iron.—The recovery of scrap so small as to pass through a half-inch riddle has received some attention in recent times. This is done mostly by means of magnetic separators. These are very likely to cost as much to operate as the iron recovered is worth. They may cost more. When one considers the transport of the material containing the iron to the separator, the feeding of it into the separator, and the further transport of the separated iron and dirt, it is difficult to see where the profit is to come in. This leaves out of view the cost and up-keep of the separator itself, and the power necessary to operate it.

It is well to avoid the confusion of idea that because it pays well to recover brass drippings and skimmings, therefore it will also pay to recover shot iron. The latter is worth only about one-fortieth as much as the former, and this low value renders the game not worth the candle.

THE GENERAL PRINCIPLES OF MINE ACCOUNTING.

By E. Jacobs.

The mine accountant and the mining engineer—the one solving the commercial problems and the other the physical problems which once made mining little better than a gamble—have put it firmly upon a plane where it is justly entitled to the name of an industry. The engineer preceded with exact methods of exploration, calculation, and working; but the accountant is his indispensable coadjutor in the determination and interpretation of results. Mr. Jacobs defines the scope, the functions, and the basic principles of the science of systematic record as applied to the mine. It is an important element of that modern movement which has changed the very conception of the working of a mineral deposit from a "venture" to a "proposition."—The Editors.

IN view of the fact that official statistics show the value of the mineral production of the United States for the year 1901 to have been $1,092,224,380, and that year by year it is being steadily augmented, it would appear that all matters bearing upon the economy of so important and widespread an industry should have close attention. One of these is mine accounting, and the purpose of this paper is to submit for consideration some fully qualified opinions and comments upon its general principles, more particularly that of cost keeping, which is deemed an essential of modern methods.

Among the many valuable articles The Engineering Magazine published last year were several in which this vital question of cost-keeping was given prominence. The subjects then dealt with and here referred to related specifically to workshops, factories, and engineering works; yet was there much pertinent criticism and instructive comment equally applicable to other industries. Indeed, a deal of this might have been written in connection with mine accounting, so apposite is it to conditions frequently prevailing where mine cost keeping is concerned.

The value of and necessity for a thorough and effective system of mine accounting does not yet appear to be nearly so generally recognized as the magnitude of the mining industry demands it should be. True, a gradually increasing number of mine owners, whether companies, partnerships, or individuals, either have already adopted or are adopting modern methods and systems which enable mine managers to review continuously the results in course of achievement, and, as a result, to have full confidence that strict economy is being practised and, at the same time, thorough efficiency secured. Yet is there room for a far wider recognition of the fact that the commercial or business part of mining enterprises must be given as close and careful attention as the technical and industrial parts—the mine engineering and the practical mining.

Not only is systematic mine accounting far from being in universal practice, but it is by no means unusual to find directorates of mining companies unwilling to sanction the employment of a sufficient clerical staff to admit of its adoption, notwithstanding that without its assistance the mine manager is seldom able at once to determine where costs are excessive and to apply the remedy. There are, too, many managers of mines who regard the keeping of accounts, particularly cost accounts, in much detail as superfluous and, consequently, as involving expense that is neither necessary nor productive of profit. Frequently this view is prompted and fostered by the existence of an imperative necessity for keeping down expenditure, and to this end the manager, either of his own volition or under instructions from his principals, as far as possible dispenses with office assistance and trusts to his own unrecorded observations and conclusions to guide him in dealing with details of management of the mine under his charge. Seemingly Mr. Chas. U. Carpenter had in mind such men—for they are to be found at mines as well as in workshops and factories—when, in the introductory paper of his excellent series on "Money-Making Management for Workshops and Factories," * he wrote: "In very many cases the superintendent is loaded down with detail work that either he or the management considers he should attend to. This is often carried to such an extreme that he cannot give his attention to the larger and broader problems for which his education, experience, and ability fit him. . . . . At times we can even find a man who has the idea that his own position is strengthened by not having strong assistants, and by keeping all the important details of the work in his own head. Repeating the trite saying of a prominent manufacturer: 'The bane of factory organization is he who keeps all important and necessary information under his hat; whether he be workman, foreman, or superintendent.' The result is that very often when the man and the hat

* The Engineering Magazine, February—August, 1902.

go out the front door, the desired information goes too, and the efficiency of the organization is seriously impaired until the problems can be taken up and solved by others." Further, Mr. Carpenter attached importance to the necessity for the head of any organization being supported by subordinates with necessary ability to care properly for a large portion of detail work so often forced upon the manager, who is paid a high remuneration because of his supposed knowledge, experience, and ability, and whose chief aim should be to achieve better results, lower costs, and investigate improved methods, machinery, and systems—an impossibility, by the way, where he has to carry the load of detail work sometimes thrust on him.

When the question of what accounts shall be kept at a mine is under consideration a serious difficulty, or what has the appearance of being one, often presents itself, particularly where it is desired to meet for the time being only the simple needs of a mining property as yet in the earlier stages of its development, and at the same time obviate the necessity for a change of system when enlarged mining operations shall call for a corresponding extension of account keeping. At first sight the books in use in an up-to-date office connected with a mine that has already arrived at a more advanced stage—not necessarily become productive, but reached a point where, for reasons of economy, comparisons of cost of work previously done and similar work in progress have become necessary—may seem to be more elaborate and to take more time (with its accompanying cost) than the circumstances of the property would appear to warrant. Again, information and assistance may be sought from published books on the subject, but these are comparatively few. Some of them give a formidable array of forms and examples, useful enough, it may be, to the student with leisure to compare their respective merits, but tending to bewilder the busy mine manager seeking a system that will provide him with well-arranged forms admitting of details of costs being clearly stated and tabulated, so as to be readily accessible at any stage of work as it proceeds.

These difficulties may be admitted, yet there remains the necessity to overcome them. Space limitations prevent going into detail here relative to particular systems, but general principles may be stated. "The first aim of a business man is to establish the principles of economy and act in accordance therewith, and it is commercial considerations which prompt an engineer to shape his practice efficiently." This contention granted, its application to mining follows as a matter of course. The next step is to decide how best to apply it. Professor J. G. Lawn, A. R. S. M., whose book "Mine Accounts and Mining

Book-Keeping" was avowedly written primarily for mining students, and deals at greater length with books and forms that more directly concern the mine manager than with those belonging more peculiarly to the province of a secretary of a mining company, says in his introduction:

> "The importance of a good system of book-keeping to a mine owner can scarcely be over-estimated. This will at once be apparent if we consider briefly some of the reasons for keeping mine accounts. They may be arranged under four heads, viz., those connected with (1) the actual working of a mine; (2) the owner (that is the individual or partnership financially responsible for the working of a mine); (3) the safety of workmen, and (4) the country at large."

Summarized, his reasons, as arranged under these several heads, may be stated as follows: (1) It is necessary to keep accounts in order that the relations of the employer and employed may be correctly regulated; that records of purchase and disposal of stores and materials and of production and sale of ore may be kept, and their influence on the profit or loss of working ascertained; that summaries and analyses of costs can be made so that the manager may be able to ascertain what proportion each bears to total cost, to learn where it is possible to economize, and generally to conduct the working of the mine in an efficient manner. (2) The owner is chiefly interested in finding out, quickly and accurately, whether the result of any period of work has been profit or loss, and why the one or the other has resulted. If profit, whether that is the result of careful and skillful management, or whether the profit ought to have been greater; if loss, whether it is due to poverty or scarcity of mineral or to too heavy expenses in any direction whatsoever, so that he may decide whether the obstacles in the way of profitable mining are insurmountable or not. Further, to understand his position fully, the owner should receive, in addition, periodical reports of the condition of the mine and its prospects. Finally, he should have means of knowing that each man employed duly performs the work allotted to him. (3) As a guarantee that careful and frequent inspections of underground workings and of plant and machinery, to guard against accidents, have been made; that proper records, signed by those responsible, are carefully kept, and that these are accessible to those interested. (4) That mines being not merely of personal and local interest, but as well undertakings of national importance, their working in most countries being regulated by law, it is important that accurate and timely statistics relative to the mining industry be published, to which end a good system of accounts must be employed. Finally, all the foregoing requirements should be fulfilled with the greatest clearness attainable, without undue complexity in the methods and books used and without unnecessary labor and expense. All books should be an effective check, should ensure accuracy and prevent fraud, and should be thoroughly adapted to the particular circumstances and needs of the mine in each case.

Mr. Kenneth Falconer, of Montreal, Quebec, who has given particular attention to the question of cost-keeping, in a forcible article published in The Engineering Magazine last April, controverting the almost universal idea that clerical and accounting work is non-productive work, makes the following among other well-founded assertions

> "Besides obtaining the correct cost . . . . a proper system of accounting should secure to the management full information as regards all the internal accounts of the business . . . . . and such changes and fluctuations as these accounts may show from time to time. More important still, it should plainly indicate the causes of any such changes whenever they may become unusual or abnormal. This information should always be a matter of current work and not of past history, and should be so promptly secured and recorded in such manner as to facilitate comparison with past records of similar operations or transactions. Thus promptly secured and systematically recorded it will enable most valuable conclusions to be drawn from it and judicious decisions to be based on it. . . . Upon the management rests the responsibility of putting such results to the wisest use as truly as the responsibility of putting to the best use any part of the equipment or of selling to the best advantage the output."

Later in his article Mr. Falconer maintains that:

> "Any office not supplied with modern appliances will be unable to procure and record the results looked for until the value to be obtained from such results is greatly decreased. A monthly statement of all details and results is valuable in direct proportion to the promptness with which it is prepared. Its value lessens greatly with each week or even day that elapses between the month to which it refers and the date it is available for study or use. Comparisons of costs to be of the greatest use should be obtainable as the work progresses, not, as is often the case, so long after its completion that they have partially or completely lost interest and value."

It is unlikely, though, that Mr. Falconer would have it inferred that comparative statements have no permanent value as such. On the other hand, as Mr. Carpenter recommends, the information and results they exhibit should be so presented that their value may be best utilized as a guide to similar operations, or future transactions under similar circumstances, which may sometimes be done by employing diagrams showing proportions and percentages, these occasionally pointing out leaks more plainly or indicating undue increase in expense more vividly than do figures representing gross amounts.

At intervals during the last two years there have appeared in mining and other journals several comparatively exhaustive articles on mine accounting and connected subjects, written by Mr. Charles V. Jenkins, accountant and purchasing agent of the War Eagle Consolidated Mining & Development Co., Ltd., and of the Centre Star Mining Co., Ltd., both of Rossland, British Columbia. One, entitled "Mine Account Keeping, and the Monthly Statement of Costs, as Adapted to the Business of Metalliferous Mining," presented the main features and principal details of the system of accounts and cost-keeping in use at the War Eagle and Centre Star mines, the practical utility and effectiveness of which system had been demonstrated by several years' convincing experience. The stated object of the writer of that useful and instructive article was "to show in a general way the practical value of a thorough system of book keeping as applied to the management and actual working of a mine; more particularly to demonstrate the utility and importance of a monthly cost sheet; and incidentally to emphasize that a very close attention to the business side of mining is as necessary to successful management as a technical knowledge and practical mining experience." In the course of his article Mr. Jenkins, after pointing out the unsatisfactory and unreliable nature of any such make-shift as a close checking of expenditures covering only short isolated periods, remarked:

> "It too often transpires that the lack or absence of economy is due to not knowing just where it can be taken advantage of. To economize, to be in a position to accomplish any degree of rightly regulated economy, the management must know not only *how* but *where* to apply it. . . . In mining, as conditions are subject to frequent change, while it is essential to know what a piece of work has cost when completed, it is of as much if not more importance to know what it is costing during its progress. A statement of mine costs to be of value must present details of cost before conditions shall have so changed as to render the information practically useless. Now, with the end in view of securing this information when it is most needed, a cost sheet should be a regular monthly statement, segregating and distributing each month's total expenses, and showing the specific charge made to every heading separately under advance in the mine; a statement itemizing and detailing each class and subdivision of labor employed, specifying the nature and amount of all material and supplies consumed, and apportioning all operating expenses and costs of power, and all of the indirect or fixed and general expenses; a statement which will admit of thorough analysis, so as to

exhibit not only the totals of the various items of cost and expense of mining, but to show correctly the cost per foot of advance accomplished, and the exact cost per ton of ore stoped. With such a statement and analysis rendered regularly each calendar month, a manager is in a position to take advantage of opportunities for economy. If the costs for any one month, or for any one heading during any month, appear abnormal or excessive, a comparison of the costs of several preceding periods will readily locate the item of increased cost, and once located, its cause can be ascertained and more than likely removed. In this way only is a manager enabled to effect a saving, or at least to reduce the chance of assured loss by being able to put his hand upon the cause of the loss and to remedy the evil, either by a redistribution of labor, by the utilizing of material to better advantage, or by improving the mechanical appliances or modifying or adapting their use to existing conditions."

What is known as the "Voucher System" is in use at the War Eagle and Centre Star mines, as well as at most of the other mines of the Kootenay and Boundary districts of British Columbia. This requires, in addition to the books ordinarily used in double-entry bookkeeping, the use of a voucher journal, so arranged and ruled as to classify and subdivide the expenditures. The number and form of the various subsidiary books are usually determined by the requirements of each individual mine, experience showing what will best facilitate and simplify the work of account keeping.

Of the system in use at the mines of the Le Roi, Le Roi No. 2, Columbia & Kootenay, and Rossland Great Western mining companies, all at Rossland, Mr. Wm. Thompson, now manager of the mines of the two last-named companies and for several years actively engaged in the management of the Le Roi and Le Roi No. 2, respectively, and who introduced this system into the offices of all these mines, in briefly reviewing the principles on which the accounts are founded and kept, remarks:

"In the first place I would say that successful mine accounting depends entirely upon the correct classification of all labor to be paid for and supplies used. The system we have inaugurated here has been carried out from time to time in the most prominent mines in the United States and Canada, and comprises the following important points: (1) A complete check against the shift bosses and time books, thus preventing any 'padding' of the pay rolls or neglect to give the men the time they worked. (2) A complete check on the work performed by every man in the mine, which being tabulated on the manager's report, at once gives him, in a very condensed form, full information as to the work performed during the previous twenty-four hours, and is absolutely necessary in works of this kind. (3) The forms of reports render available, for the guidance of the accountants, a correct basis on which to apportion the general expenditures between Capital and Revenue accounts. Lastly, I would add that the greatest possible care is taken in recording and checking the shift bosses' reports, supplies used, etc., so that a balance is struck every day, and that the reports can be absolutely relied on for accuracy. When the final reports reach the accountants it is very easy matter for them to record the expenditures. It then becomes a question of simple book keeping, using any forms of books available to simplify the work, and having as few entries in the main ledgers as possible."

The reports referred to include those made daily by the shift bosses, which are checked by a separate report from the time keeper; those covering ore production, breaking, and sorting; reports of powder and other supplies used, etc. A weekly mine-labor report and a monthly summary of development labor are also in use. The chief book recording details is designated the Grand Journal, much condensed summaries from which are posted to the ledger in the ordinary way. The monthly statement, showing details and costs of mining operations for the month, is a comprehensive return, with complete information ascertainable at a glance.

Summed up, the chief burden of all the foregoing is cost keeping, and since in all costs the two prime factors are labor and material, experience shows the leading principle of mine accounting to be an accurate and continuous calculation and compilation of expenditures, to secure comprehensive information that will afford a conclusive reply to two main questions: (1) Are all employees giving a full day's work? (2) Is there any waste of stores or other materials? Time and again it has been absolutely demonstrated that large savings and increased efficiency have resulted from the introduction of a rational and complete system of cost-keeping accounting covering all construction, equipment, operating, maintenance, and materials accounts. The ultimate object of this accounting is cost reduction, which can best be secured by mine managers having an intelligent, systematic, and uninterrupted recording of details in daily progress to rely upon for their guidance.

METAL CUTTING WITH THE NEW TOOL STEELS.

By Oberlin Smith.

The extension of the use of the new fast-cutting tool steels is one of the most significant developments in modern machine-shop practice—one of the most fruitful in its possibilities of scarcely foreseen changes. Mr. Smith has been an earnest experimenter in the practical working of the new steels, and in the following pages he outlines some of the certain changes which they will bring in tool design and machining operations.—THE EDITORS.

LOOKING back through history, not perhaps to primeval times, nor even so far back as the days of Tubal Cain, but only through those centuries in which men have practiced the art of cutting the harder metals, such as iron and steel, by means of hardened steel tools, we find that the machine shop has been but a school for the cultivation of a leisurely pessimism.

Reference is here made only to those tools which work upon the shaving or paring principle—not to those which perform shearing and punching, mounted in shearing machines and presses, or of abrading by the use of grinding apparatus. During an unknown number of centuries lathes have been employed for turning metals, at first by the use of hand-held cutting-tools, and later on by tools held and guided in a slide rest or its equivalent. Drilling machines of various kinds were doubtless in use as early as, or perhaps earlier than, turning lathes.

The application of the simplest slide-rest principle developed machines carrying automatically guided tools for almost all forms of metal cutting, including highly specialized apparatus of great power and accuracy. These waited for the commencement of their present great development until early in the nineteenth century. We need not look back more than a hundred years to see the feeble beginnings of the planer, nor half as long for the shaper and milling machine. We need, however, look in retrospect through but a few years to see machine-shop processes carried out on the magnificent scale which have produced so quickly and cheaply all the tremendous machinery plants of the civilized world.

And yet a visitor in one of our splendidly equipped shops, with every machine running at its full capacity, could, if of a philosophical yet enterprising turn of mind, but be depressed with the inevitable slowness of all the motions going on around him. Who of us has not felt a certain sadness at seeing so many men enjoying a happy idleness, perhaps even for hours at a time, watching the creeping motion of great pieces of metal as they revolve or slide against the tools which slowly bring them to shape by shaving off a few pounds of chips per hour? Who among us has not pictured some ideal future process whereby metallic articles could lose their skins, so to speak, with somewhat more of the hustle and vim incident to wood-working and even to shoe-making establishments, where everybody seems to be going ahead, instead of sitting still? Who has not been subdued and made pessimistic by the apparent utter impossibility of improving the metal-cutting business, with its speeds of from 10 to 30 feet per minute, often averaging less than 20, even in a well managed shop? Who has not felt that machine work was bound by the laws of the Creator to be performed slowly, and that the machinery produced thereby was necessarily to remain phenomenally expensive? And who has not drawn comparisons, and noted the strong contrast between the production of this class of work and that practiced in saw mills, or cotton factories?

A new era, however, is not only dawning, but seems to have almost burst upon us in full effulgence. Its beginnings are almost coincident with the birth of this marvelous and to-be-mighty twentieth century. Where a few years ago wrought iron and the milder forms of steel (those all-important components of machinery) could be cut at an average rate of about 20 feet per minute, we may now regard from 50 to 100 feet per minute as a conservative estimate for the actual practice attainable by any machine shop, from this time on—that is, under conditions where the work or the tools, as the case may be, can be run at such speeds with a smooth and uniform motion, as is the case with ordinary, straight, lathe work, such as shafts, axles, etc.

As is well-known, the cruel limitation in speed of former historical times (that is of a year or two ago), which seemed to all of us an insurmountable one, was due to the frictional heating of the tool, and its consequent softening by the drawing of its temper. Some improvement in this respect was made when the so-called self-hardening steels were introduced, several years since; but practically no very considerable increase of speed was obtained, as with much faster running these tools seemed to break or be rapidly abraded out of shape. With certain tools of the milling-cutter type, considerably higher speeds were attained by having a great many cutting edges to do the work, so that a great majority of them could be out of service and cooling, while a few were actually cutting. By this means, and by the liberal use of a cooling lubricant, practical milling speeds upon wrought iron were obtained as high as about 80 feet per minute, but these were not found possible in ordinary turning or planing, even with thorough lubrication. The highest recorded speed known to me that has been attained under the old *régime,* with the very best quality of tool steel, was in the drilling of certain gun barrels, where a powerful stream of cold oil was forced through the drill under a heavy pressure, so as constantly to cool its cutting edges and keep them comparatively clear of chip friction by carrying the chips outward in its rapid torrent, alongside the shank of the drill. Under these extremely favorable circumstances speeds as high as 100 feet per minute have been reached, but nothing approaching this was possible in ordinary work.

In considering this question some of us have dreamed dreams and have pondered upon complicated schemes for doing cutting work in tanks of freezing mixtures, or for changing temporarily (perhaps in some chemical or electrical way) the molecular construction of the metal to be worked. All these have been swept away, or laid aside for the time being, by the men who have actually accomplished what the world has so long sought for, and that by the simplest means, the only change being in the material and the heat treatment of the cutting edge of the tool. May all honor and much profit come to these faithful pioneers!

This seemingly trivial, but mighty invention, is about as young as the century, the tools in question having been used in actual practice, upon a commercial scale, but for a very little time past. Meanwhile, a further development has taken place, not only in the high-speed quality and the strength of the various steels experimented with, but more especially in simplicity of treatment during the hardening process.

Many machinery manufacturers appear to have been waiting for a cheapening of the very considerable expenditure which at first it seemed necessary to incur—both for the new tool steel itself and for the special apparatus for hardening, and otherwise treating it. They felt that a time might soon come when no special plant would be required for its use and when, as with all new inventions, various improvements would reduce the cost of the article invented to a basis comparable with that of its older rivals.

The wished-for time in question seems to have come even sooner than could have been hoped for. Suddenly, almost, there have appeared in the open market various brands of high-speed steel, manufactured both in Europe and in America, which, to a greater or less degree, accomplish most marvelous work, and work which would have seemed almost impossible a few years ago. Not only will these new tools cut two-fold or three-fold faster than the best tool steel of the recent past, but their durability is in some cases amazing, as when a lathe tool will run several hours in cutting forged steel with no sharpening except perhaps the slight filing off (without removing from the tool post) of a burr which builds itself up upon the top surface of the cutting edge from fine particles of the steel being cut, which seem to weld themselves fast. This burr does not break off until after the tool has been used long enough for the chips to dig a decided hole in its upper face, thus leaving the cutting edge much more acute than it was at first and giving the burr less chance to hold on. After a tool has been concaved this way too much, a little ordinary grinding of the top face will restore it to good working order.

In some cases the chips will be heated to a dull red with the tool nearly as hot. When working efficiently it is never expected that the chips will come off as bright metal, the heat naturally discoloring them to a deep blue, or beyond the blue stage to a grayish black. Water upon the tool is of some advantage, but, fortunately, the new steel does excellent work when perfectly dry, thus avoiding the inconvenience of wet cutting.

Furthermore, some of this steel seems to delight in being abused, maltreated, and persecuted to the utmost degree. One kind recently tested by me apparently suffered not at all by having its cutting edge burnt to the melting point, the whole treatment of hardening being extremely simple, in an ordinary forge fire—and this without the danger of "temper cracks" incident to the old-fashioned steels.

With this particular grade of steel, a speed of over 200 feet per minute was attained in turning a 4-inch forged-steel shaft of about 0.50 per cent. carbon, but the cutting edge gave out after running along several inches. Shafts of the same kind were readily turned, however, at 160 feet per minute, as the steel was originally received from the makers. On one occasion a tool ran for seven hours at nearly this speed, but the work might have been a little softer than above mentioned. Speeds of from 80 to 120 feet per minute have since been attained as a regular every-day occurrence, upon medium hard steel, but no exhaustive experiments have been made to determine suitable speeds for wrought iron and mild steel. With cast iron it has been found practicable to use these same tools at speeds of from 40 to 50 feet per minute only. Other experimenters, however, have attained speeds of more than 100 feet upon cast iron, with tools especially tempered for cutting this material.

A statement has recently been made public regarding a new German tool steel which will cut forged steel at 150 feet a minute and cast iron at 120 feet. Much durability is also spoken of, the tools running without grinding for many hours, and sometimes for many days. It is certainly to be hoped that this is all true, for actual work, but tool users feel that the whole subject is still somewhat in an experimental stage. From the evidence thus far obtained there seems to be no question that 100 feet a minute for many of the ordinary machine-shop operations will be a future standard, instead of the 20 or 25 feet which so many people have heretofore contented themselves with.

Besides this wonderful increase in speed, we fortunately have greater strength and far greater durability in the cutting edges of these tools, so that less time is wasted in removing, grinding, and replacing them in the machine. They have, moreover, a capacity for deeper and wider cuts than usual, with a consequent greater weight of metal removed per foot of travel. When this increase is multiplied by the higher speed, together with, as above mentioned, longer continuous running without grinding, it must be apparent to all that we have suddenly arrived at a new and perhaps startling era in the art of metal working. What this means to the industrial world, from the point of view of the political economist and social scientist, to say nothing of statesmen and politicians, we probably none of us realize at this time. The changes that are destined to occur in the cheapening of machinery making, with the consequent impetus that will be given to its production, are for the future to determine. That they will have a marked influence upon the whole civilization of the world, as the improved methods gradually become standardized, there can be no question.

Looking again at this subject from a merely mechanical standpoint, we must not only deal with the question of increased speed in the spindles and countershafts of our lathes and other rotary tools, attained probably in most cases by speeding up the line shafting also; but, to get the full effect of the impending reform, we must have the machine-tools themselves built much stronger and heavier. This will be needed, not only to allow for the additional vibration due to the higher speed, but also for the heavier chips that we expect to remove. This obviously means that the present designs of machine tools will gradually become obsolete, and that new ones will be designed which are vastly more massive and rigid than the majority of the types in present-day machine shops.

When several years ago I earnestly advocated in the columns of the *American Machinist* the use of a much heavier framework for machine tools, together with large spindles and long bearings, contrasting this desired "anvil principle" with the "fiddle principle" so universally present at that time, I of course could not foresee the coming high-speed, heavy-chip era, which probably may force the anvil principle, in an intensified degree, upon many heretofore reluctant designers and users. This means that the frame or bed and other stationary parts of a machine cannot be too heavy, so there is room for a man to walk around it. The slowly moving parts should also be as clumsy as is consistent with convenient handling. The cost of extra cast iron should be considered not at all. We must buy all the inertia and rigidity we can get—at any price.

In altering and reequipping machine shops for the new methods it must be remembered that these high speeds and heavy cuts will take much more power than formerly, and this will mean the improvement and increase of generating and transmitting machinery.

In doing this it is to be hoped that one of the incidental changes will be in the line of abolishing shafting and belting as much as possible, and in the use of individual electric motors especially adapted to each machine—in some cases forming a component part thereof. Heretofore the high cost of motors, and the difficulty of obtaining many variations of speed under greatly varying loads, has retarded the development of such electrical driving. Recent improvements in design and in methods of manufacture have, however, removed some of these difficulties. Still other improvements, especially in the matter of motor control, are no doubt destined in the near future to bring the electrical machine shop* boldly to the front.

It will be noticed that reference has more than once been made to the speeding up of rotary machines. Obviously, drilling, boring, and milling machines may have their speeds increased to almost any extent, as the rotary parts are of moderate size and usually symmetrical. Thus high speeds will not prevent quick starting and will not throw them out of balance. The same thing applies to lathes, when the work is circular, as in case of wheels, straight shafts, etc. In the case of irregular lathe work, like crank shafts, and other non-symmetrical objects, there may be considerable limitation in regard to rotary speed.

* See Mr. Kimball's article elsewhere in this issue. In May and June the papers in Mr. Kimball's series will be devoted especially to the electric motor in the machine shop.

although much can sometimes be done by proper attention to artificial balancing.

In considering reciprocating machines we have an entirely different problem, although in cases where the tool, rather than the work, moves, as in shapers and slotters, no great difficulty need be expected in arranging for the new speeds, as the parts affected by inertia, when changing their velocity, are usually not very heavy. In the case of planers, however, where the work itself, together with the large table of the machine, reciprocates against the stationary tool, we obviously cannot expect much greater speed than at present, especially in the case of large machines carrying very heavy work. The inertia of such weighty reciprocating objects, which must stop and start several times a minute, will certainly prevent the high cutting speeds desired.

A friend suggests that at the other side of the scale stands the very large class of operations in which the limits are set, not by the strength and capacity of the tools or the machines, but of the work itself, it being of small advantage to save time in turning a light shaft, for example, and produce but a snake. This criticism well applies to one point referred to—the taking off of bigger chips—but it is not pertinent to the greater advantage obtained by a high speed. A light shaft can be run fast as well as slow, providing it is symmetrical and is properly guided by "follow rests," etc.

An exception to this statement may sometimes be necessary in the case of very small shafts in which there is so little body of metal that the shaft gets almost as hot as the chips—so much so as to warp out of shape. In recent experiments, however, a 1-inch shaft was reduced at several cuts to ½-inch and remained white, with the chips coming off at a deep blue color.

In view of the foregoing it would seem that for larger work at all events, an incidental effect of the little chemical changes which have been worked out in the crucible, upon some pieces of iron mixed with certain carbon and other stuff, will not only serve to change various economic aspects of the world by billions of dollars, but, mechanically speaking, will tend to substitute milling machines for planers, and will so change the design of the planers themselves as to make them move the tool rather than the work.

Just how all the things here hinted at will work out in practice within the next decade or so it is difficult to foretell; but whether or not some very radical alterations will, by reason of the various causes now appearing, be effected in our machine shops would seem to me, at least, to be a question with but one answer—and that, of course, the unhesitating affirmative.

It should not be inferred from the foregoing facts and deductions that the mechanical world is to be immediately reformed, after the manner of a tidal wave, so to speak. A natural feeling of conservatism and a disinclination to spend more money than seems absolutely necessary will, for some time to come, deter many shops from making radical changes, especially in the way of a re-equipment with heavier tools. It must also be remembered that the large aggregate saving in the cost of production, which will be the eventual result of the new methods, will not be so immediately apparent, by reason of the fact that the gains will be, for the first few years, largely offset by an enormous cost account in making the change. Much economy will doubtless result, in perhaps a majority of our present machine shops, merely by the substitution of cutting tools made of the new high-speed steels, to be used in connection with the present machine tools, these latter being speeded up by comparatively inexpensive changes in pulleys, belts, etc. In this case, however, it will often be necessary to increase the steam plant or other source of power, because on such machines as are run at a high speed the necessary horse power for driving will be increased in about the same ratio as the velocity. This, however, cannot, as before remarked, apply to all the machines in the shop, but only to those which are not handicapped by reciprocating motions, or by the rotation of irregular work.

Meanwhile, the substitution of different types of planers, together with heavier and stronger machines in general, will go on gradually. The great expense incident to this change, by reason of making many of the old tools obsolete, and because the new ones will each be heavier and more expensive, will be incurred gradually, especially in the older shops. The grand change in machine-shop methods hinted at in this essay will not, therefore, occur as a cataclysm, but will come upon us gradually, though perhaps with an increasing velocity ratio, during the years of a coming decade or two—thus giving us ample time to become thoroughly accustomed to the change.

COST-FINDING METHODS FOR MODERATE-SIZED SHOPS.

THE SHOP SYSTEM OF THE CANADIAN COMPOSING COMPANY.

By Kenneth Falconer.

The series of articles of which this is the fifth began in December last with an account of a system in use in a well-managed boiler shop. In January the example taken was a machine-tool works using the premium plan, and in February, a printing-press factory in which stock tracing was a peculiarly important feature. Last month the description was of an efficient but simplified and standardized system employed in an engine and boiler works. The following paper concludes this group. The purpose of every one has been to furnish a working description of a practical system, in actual use in a shop where it has stood the test of time and proved sufficient, and with this to give fac-simile reproductions of all forms and blanks. This makes the articles particularly useful to those concerned with shop accounting.—The Editors.

THE Canadian Composing Company, Ltd., of Montreal, manufacturing the Monoline composing machine, employ some 125 to 150 hands, about 30 of whom are girls. The nature of their product demanding perfect workmanship and interchangeability of parts, the greater number of their employees are highly skilled mechanics; the fact that they manufacture one machine only, together with the fact that practically all the parts entering into its construction are of such size as to be easily handled by one man, greatly simplifies the question of handling material and work in process of manufacture. The stores department are thus enabled to take the responsibility of preparing and issuing the material required for a productive order, as a consequence leaving the foremen free to devote all their attention to the actual productive work of the company. For the sake of distinction, that part of the stores responsible for this work is known as the "stores-distributing room."

Under the immediate control of the superintendent and his assistant are the stores-distributing room, the stock both of rough material and of finished parts, the tool room, the rate-fixing and inspection department, and the cost department. Productive orders for the manufacture of a machine or lot of machines go to the assistant superintendent, and are entered in an order book in the stores-distributing room. This book is under the control of the store keeper, who is also the distributing clerk, and on him is the responsibility of having on hand enough finished parts to supply for such orders, and the necessary material to keep up to a safe limit his stock of finished parts.

PIECE ______ WEIGHT						
RECEIVED				SENT OUT		
Date	Order No.	No. Pieces	Weight	Date	No. Pieces	REMARKS

FIG. I. STOCK LEDGER FOR FINISHED CASTINGS.

Original is 7¼ inches wide, ruled in red and blue on white paper.

SIZE ______							
RECEIVED				SENT OUT			
Date	Order No.	Feet	Weight	Date	For Part	Feet	Weight

FIG. IA. STOCK LEDGER FOR RAW MATERIAL.

Same size, etc., as Fig. 1. The cuts give the heading and method of ruling only. The originals of course are much longer.

CANADIAN COMPOSING CO., Ltd.

High ______________

Low ______________ Part No. ______________

Date.	Rec'd.	Date.	Used.	Bal.

FIG. 2. STOCK CARD. HEADING AND RULING.

The original is 3½ inches wide by 7 inches high, manila card.

LIST OF MATERIAL TO BE SAWED FOR 15 MACHINES.

Machine 27.

KEYBOARD.

B.	NAME OF PART	MATERIAL	THICK	WIDTH	LENGTH	NO. OF PIECES
300	Top of front comb	Tool steel	3/16	5/8	11 11/16	15
451-452	Right and left bearings	Cold rolled	3/8	3/8	4 5/8	30
11010	Front bar	Cold rolled	1/4	7/8	11 3/8	15
11702	Spring comb	Brass	3/16	1 1/4	11 9/16	15

MAGAZINE.

C.	NAME OF PART	MATERIAL	THICK	WIDTH	LENGTH	NO. OF PIECES
3	Back plate	Mach. steel	3/8	3 1/2	10 9/16	15
50	Partition plate separator	Cold rolled	3/16	3/8	7 3/16	15
281-5	Thicking piece for front end of Accelerator lever	Tool steel	3/32	5/8	3	25
286-8	do. do. do.	Tool steel	1/8	5/8	3	25
309	Lock slide	Mach steel	1/4	3/4	7 1/2	15
311	Angle piece	Cold rolled	1/4	5/8	8	1
327	Toggle	Tool steel	1	1 5/8	8 3/4	3
346	Lock on latch	Tool steel	5/16	5/16	3 3/4	3
349	Thickening piece to connect latch	Tool steel	1/2	3/4	5	2
357	Auxiliary ejector	Tool steel	1/8	1/2	2 15/16	15
358	Ejector	Tool steel	1/2	1/2	3 1/8	15
364	Bearing for retaining pawl	Mach. steel	3/8	5/8	6	2
365	Block on top of space box	Mach. steel	5/8	7/8	6 3/8	4

FIG. 3. LIST OF MATERIAL REQUIRED FOR 15 KEYBOARDS AND MAGAZINES.

Figures 1 and 1A show the ruling of two of the stock ledgers, of which a complete set are kept, covering all lines of raw material and finished parts.

Figure 2 is a stock card, kept on the shelves or bins with the goods to which it has reference. All receipts and withdrawals are noted on this card, so that should the quantity on hand drop below the limit, the fact is at once brought to attention and an order issued to manufacture a further supply—usually the quantity required for fifteen machines.

The parts of which a Monoline composing machine is composed are each known by a number, each group of numbers being indicated by a prefix. Thus the letter B may represent the key-board, the various parts of which it is composed being known as B1, B2, etc.

Figure 3 is a section of a list kept in the stores department showing the exact quantity, dimensions, and kind of material required to make a given number of each part. When an order (Figure 4) is issued for the manufacture of any part it is entered in the order book, and the rough material drawn from stores and cut to dimensions as

Order ______

The Canadian Composing Co. Limited.

Montreal Feb. 3 190 3

To Mr. F. Lefebvre

MATERIAL REQUIRED.

X A.M. P.M. Feb. 12th 190 3

2 Sets of Matrices #8. 4

4 Sets of Space-bands

Accepted W. W. Wotherspoon

F. Lefebvre Supt. *Dept.*

Foreman of Matrix *Dept.*

Remarks ______

THIS REQUISITION REQUIRES A DEFINITE ANSWER.

FIG. 4. ORDER FOR PARTS.

Original is 4¼ inches wide by 5 inches high, thin white paper, joined to duplicate by perforated margin on the left. Signed and date promised (at point marked X) by foreman.

called for on this list. Figure 5 is a page from the Book of Operations, copies of which are in all the shops as well as in the stores-distributing room. This book shows in proper sequence the different operations each part undergoes during manufacture, the machine on which each operation is done (which usually bears the same number as the man operating it); and the tools required therefor.

When the material is ready it is placed in a box and sent to the stores-distributing room; an order ticket (Figure 6) is then made out and placed in a holder on the end of the box, and the necessary tools as called for by the book of operations are taken from the tool shelves and put in a box the same size as that containing the material, but painted a different color. The lot number and part number on this order ticket practically form the order number to which the material is charged, and to which the workman later on charges up his time. These and the operation number are filled in, leaving the workman's name and time of starting to be noted when the material is taken to the shops. Around the two sides of the stores-distributing room runs what is generally spoken of as "the rail." This is an ordinary railing or balustrade enclosing the tool racks and stores-distributing room, and leaving a passageway leading to

Op. 1—Wind in piece 6 in. long.
Machine—15.
Op. 2—Cutting off.
Man—35.
Op. 3—Finishing ends.
Man—35.

C 364—BEARING FOR RETAINING PAWL.

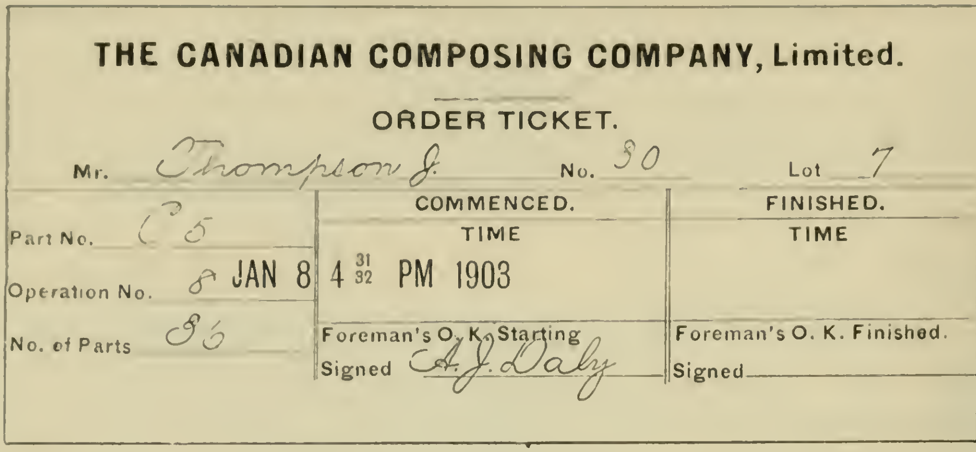
Mat.—Machinery steel. Two pieces 6 in. long.
List No 4...... ....: .... Drawing No. 139
Mat.—Machinery steel.
Size—3-8 in. thick, 5-8 in. wide, 6 in. long.
Op. 1—Milling front.
Machine—5.
Op. 2—Milling right-hand side.
Machine—5.
Op. 3—Milling left-hand side.
Machine—5.
Op. 4—Milling back.
Machine—5.
Op. 5—Sawing off.
Machine—5.
Op. 5a—Butt milling ends.
Machine—5.
Op. 6—Drilling.
Have jig.
Drill No. 44.
" " 28.
Machine—33.
Op. 7—Slotting.
Have cutter.
Machine—5.
Op. 8—Slotting angle with a parallel to straddle vise.
Use same cutter as Op. 7.
Have parallel.
Machine—5.
Op. 9—Countersinking.
Machine—33.
Op. 10—Reaming.
Same reamer as C 348, Op. 8.
Machine—33.

C 364a—RIVET.
List No. 8 ... ...Drawing No........
Mat.—Soft wire.
Op. 1—Cutting off.
Use wire cutter.
Boy.

C 365—BLOCK ON TOP OF SPACE BOX.

List No. 4...... ....Drawing No..........
Mat.—Machinery steel.
Size 5-8 in. thick, 7-8 in. wide, 6⅝ in. long.
Op. 1—Mill back.
Machine—5.
Op. 2—Mill right hand side.
Machine—5.
Op. 3—Mill left hand side.
Machine—5.

FIG. 5. BOOK OF OPERATIONS.



THE CANADIAN COMPOSING COMPANY, Limited.

ORDER TICKET.

Mr. Thompson J. No. 30 Lot 7

Part No. C5

Operation No. 8 JAN 8 4 31 32 PM 1903

No. of Parts 86

	COMMENCED.	FINISHED.
	TIME	TIME
	Foreman's O. K. Starting	Foreman's O. K. Finished.
	Signed A. J. Daly	Signed

FIG. 6. ORDER TICKET.

Original is 5¾ by 2⅝ inches, yellow card. Date is filled in by time-clock stamp.

the entrance of the shops; on it, at regular distances, are painted numbers corresponding to those of the men or machines. The company assert: "This takes space but pays."

The shops are worked on the gang system, a sub-foreman being in charge of a small number of men and responsible for keeping them continuously supplied with work. Each morning at a certain hour these sub-foremen visit the stores-distributing room and notify the assistant superintendent what men or machines are likely to be out of a job during that day. Together they consult the order books, and having decided to which order to give precedence, the boxes containing the necessary material and tools for it are placed beside the rail opposite the number of the machine on which the next operation will be done, the workman's number being entered on the order ticket and noted in the order book. For expense or repair orders the order ticket used is practically the same as that shown, but of a different color, and has a page number substituted for the lot and part number. This page number represents the page of the expense cost book to which all charges against such work are posted.

On coming to work each morning the workmen pass through the stores-distributing room, and each receives a time card (Figure 7) on which the date and time is marked. The clock for this purpose is kept beside the door leading from the stores-distributing room to the shops. On reaching his bench the workman fills in all other particulars called for on his time card from the ticket representing the order on which he was engaged the previous day, and as a rule he continues on the same job until completion of the operation or operations specified on the order ticket. In exceptional cases an order may be suspended and a rush order given him in its place; in such case the ticket for the suspended order is kept in the stores department until such time as it is determined to put it in hand again.

On completion of the work called for on the order ticket, the workman takes the two boxes, one containing it and the other the tools he has used, to the inspection department. He knows that beside the rail, opposite the number of his machine, he will find the material and tools for the next work he is to take in hand. After delivering the boxes at "inspection," he stamps the time card he has been using, turns it into the stores-distributing room, and receives another with the hour and date marked on it; all other particulars he fills in from the order ticket which accompanies the material and tools handed to him by the stores department from beside the rail opposite his number. All loss of time "between jobs" is thus eliminated. Before any workman has completed any given operation the material and tools for the next job are ready for him, with full instructions as to the operation which he is next to undertake. On receipt of material and tools by "inspection," both are carefully examined and the former either sent back to the stores-distributing room for the next operation, or to stock if completed. In the former case an order ticket bearing the same number, but indicating the next operation, is made out and it is then treated exactly as if it were a new order. The tools are never returned to the tool shelves unless in perfect order. If they require repairs, a check showing the disposition of them is placed on the tool racks; otherwise they themselves are sent back to the stores and returned to their proper location.

Orders for assembling a machine or a lot of machines largely follow the same routine. The parts required are supplied in proper

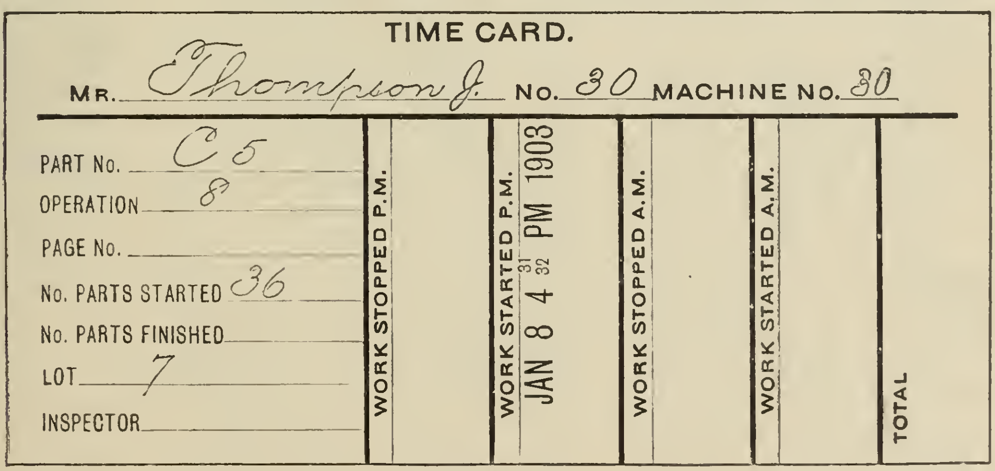


FIG. 7. TIME CARD.

Original is 5¾ by 2⅝ inches, blue card. Time is filled in by time-clock stamp.

Page No. **1723** **THE CANADIAN COMPO**

No. of Part.	Opera-tion.	NAME OF EMPLOYEE.	Employees No.	Machine No.	INSPECTION.											
					DAILY TIME AND NUMBER ACCEPTED.											
					SATURDAY.		MONDAY.		TUESDAY.		WEDNESDAY.		THURSDAY.		FRIDAY.	
					Hours.	Pieces.	Hours.	Pieces.	Hours.	Pieces.	Hours.	Pieces.	Hours.	Pieces.	Hours.	Pieces.

SING COMPANY, LIMITED. Page No.

STARTED.			COMPLETED.			Time to complete work.	PAYMENT.					COST.				REMARKS
							Day Rate.	Differential Piece Rate.								
								To Receive Highest Price Work must be done at Rate of								
No. of Pieces.	Mo.	Day.	No. of Pieces.	Mo.	Day.	Hours.	Payment per Hour.	Pieces in	Hour	High Rate	Low Rate	Labor.	Material.	Totol.	Cost of One Piece.	

FIG. 9. COST BOOK. THE REPRODUCTION SHOWS THE HEADINGS AND METHOD OF RULING.
On account of its width, the page is shown in two sections. The lower cut should be placed to the right of the upper one.
The original is 17 inches wide.

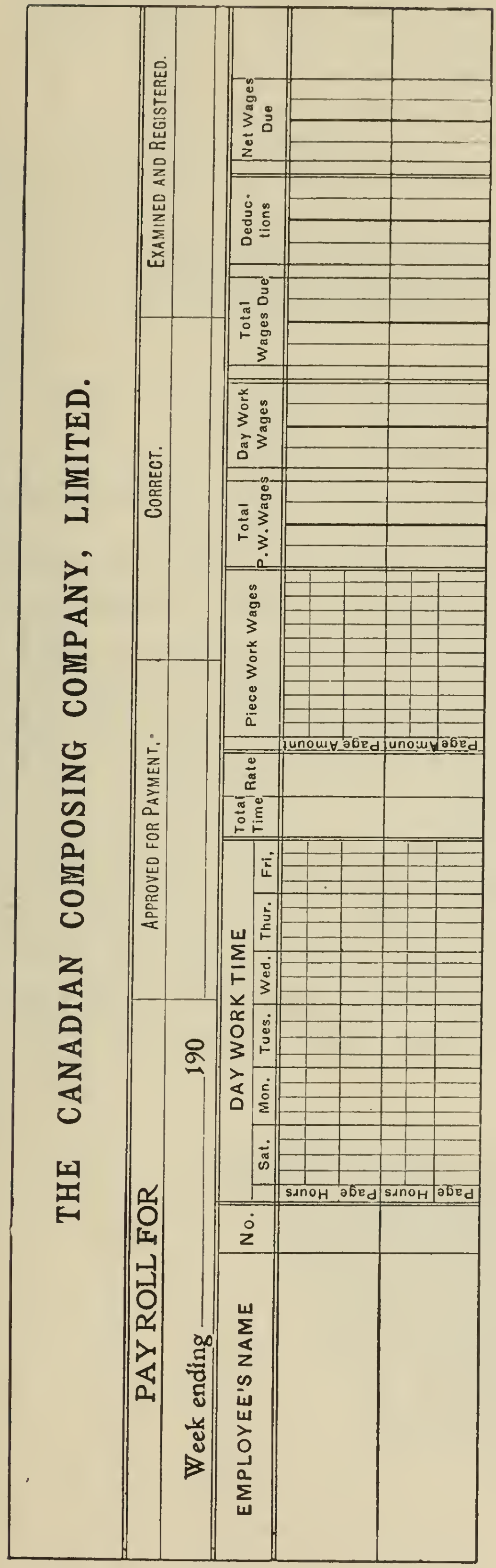


FIG. 10. WEEKLY PAY ROLL, SHOWING HEADING AND METHOD OF RULING. ORIGINAL IS 13 INCHES WIDE.

rotation from the distributing room, the necessary tools, however, being kept in the assembling room under charge of the foreman of that department.

Figure 8 (page 98) is the back of such order tickets as are issued for operations paid for by piece work. It will be seen that the system in use is the Taylor differential piece-rate system, which has been fully described in the Works Management Number of THE ENGINEERING MAGAZINE. The management find that their gain in increased output fully justifies them in paying the high rate if the work is done within the limit set.

Figure 9 shows the ruling and heading of the cost books. The workman's time ticket and the reports from inspection are entered up in these books each day, and it will be seen that the management are thus always in close touch with all work in progress, its condition, and its location. The cost book shows only the labor and material cost, the proportion of shop expenses being added in the office.

Before leaving the works each man turns in his time card for the job on which he was engaged at quitting time, but leaves the order ticket for such job at his bench with the

CONTRACT.

DAY RATE	DIFFERENTIAL PIECE RATE.				
	To Receive the Highest Price, Work Must be Done at the Rate of				
Per Hour	PIECES IN	HOURS.	HIGH RATE.	Low Rate	Lowest
20c	1	2	70¢	44	28
	36	72	$25 20	15 84	10 08

The person accepting this contract for piece work agrees to complete the work specified on back to the satisfaction of the inspector, and for the amount named in the contract.

Only such work as passes inspection will be paid for, and the workman will be charged for lost labor on parts spoiled while he holds this contract, unless occurring from a cause for which he was not responsible.

Mr. ______________ No. ________

FIG. 8. BACK OF ORDER TICKET FOR PIECE-WORK JOBS.
Original is 6 inches wide by 2⅝ inches high, green card.

unfinished work. The time, as shown by the cards each day, is credited to him; no other record of his entrance or departure is kept.

Figure 10 is part of the weekly pay roll, which is made up from the workmen's time cards. For convenience, fractions of hours are figured in decimals, and the time clock was especially made so to record the time. In case of any error or dispute with a workman, the pay roll can be at once verified by reference to his time cards. As these have been made out and signed by himself, it will be seen that he is to all intents and purposes his own time keeper.

As has been stated, the Canadian Composing Company work under circumstances exceptionally favorable to securing both continuity of manufacture and maximum of output. Where a greater variety of product is manufactured this system would not be applicable in its entirety, but there are points of merit in it which might be applied with advantage to some department or shop of very many productive organizations.

EDITORIAL COMMENT

THE archaic state of the labor problem—which it is Mr. Carpenter's earnest purpose in his leading article in this issue to point out and to amend—is one of the most anomalous and inexcusable features of the times. At every other point in the whole industrial system, fore-sighted and far-sighted economy is in supreme control, shaping the design and directing the working of every part. Loads and strains are calculated and provided for; friction and wear are forestalled; wastes are foreseen and remedied or utilized; emergencies and interruptions are prevented, or their possibility and power for harm are minimized; forces are gauged with nicety to the work to be done; costs are figured to the uttermost of exactness. It is our boast that productivity is being constantly and rapidly increased, and that the productive industries are being brought more and more under the control of the engineer, whose characteristic function was recently defined in these pages as being "to know and to foresee exactly what are the conditions affecting every step he takes."

But turn to the field of labor, and all this science gives way to rule of thumb—or to no rule at all, but the little-better-than-brutal plan of "muddling through." Here and there a manufacturer studies the nature and needs of the vital factor in production—the workman; here and there is put forth a policy based on careful study of the real economy of human effort; here and there a system is advanced aiming at development of the best efficiency of the man. But even when these things are tried, it is often so half-heartedly or so less-than-half understandingly that the possible good is lost. Manufacturers who would not think of installing new motive power, or changing a transmission system or a tool drive without careful education of those affected, assume that a novel and complex wage system can be suddenly introduced by mere act of will.

But it is all too rarely that anything in the way of advance is attempted. Too generally, even yet, the idea prevails that the sole rule to follow in dealing with wage workers is to pay as little as possible for a "day's time," and that further relations can be left to the charge of almost any one, as a side issue to general duties of management or sub-management. Nobody would think that about a dynamo, and yet a dynamo is a far less complicated machine than a workingman.

It ought not to be thought unnatural that labor, finding itself invested by unionism with a power as arbitrary as that heretofore exercised by some employers, should fall into the same evil fallacy and think that "You shall" and "I will" are the ultimate law, providing only there is strong enough physical force behind them. It is no wonder that unionism has made itself odious by tyranny and unreason, especially, as Mr. Carpenter suggests, since the attitude of employers has held back the more conservative workmen and turned over the labor councils to the radical and violent. And so the commonest—one might almost say the usual—relation of organized labor to organized management has been in some "test of strength"—generally a "test to destruction," in the desires at least of the parties involved. Think of applying the same fatuous methods to the mechanical power plant!

What both sides must learn, as the anthracite strike in the United States has made clearer perhaps than ever before, is that there are higher laws of "anthropo-dynamics," just as there are of thermo-dynamics—higher principles of conciliation, as there are of lubrication—which must be recognized before any true economy can be reached in productive effort. Any conditions forced against the dictates of these laws involve inevitable friction, waste, and destruction.

In short, the dictation of conditions by either employer or employed, without due regard to the essential interests of the other side, is false practice. And the attempt to maintain it by appeal to force is intolerable to the new conceptions of the inherent virtue of economy and the innate sin of waste.

And the fundamental need for the furtherance of this ideal is—Conference. "*The time to stop trouble is before it begins.*" Conference, in a spirit of common justice and common sense, would do wonders in changing the reciprocal feelings and attitude of employers and employed. And unionism, deplorable and hideous as are many of its present manifestations, is the most promising agency for the efficient development and application of the power of conference.

* * *

THERE has rarely been a more striking example of the power of the truth than is afforded by the final adoption of the Panama route for the Isthmian Canal. It has prevailed by an almost unanimous vote of the Senate, although a very few years ago it was about as friendless a proposition as ever ventured to ask for a fair hearing. And for the entire intervening period of investigation and discussion, it has been the target for the most unmeasured and the most insidious attack which the lobbies or the floors at Washington, and the columns of an insistent section of the press, could devise and direct.

It has had to fight its way against widespread misconception and reckless misstatement—partly ignorant and partly malicious—as to the physical and financial conditions to be met; against false sentiment and misdirected patriotism which had been taught to think the route "less American" than some other; against mysterious pressure exerted to suppress every evidence of its superior advantages and to gild the very indefinite prospectus of opposing schemes; against the over-reaching greed of French owners and the obstinate folly of Colombian "statesmen"; against the sinister tactics of transportation companies which considered (in utter mistake, we firmly believe) that the opening of an Isthmian Canal would be adverse to their interests; against, finally, the bitter personal enmity of the senator who had always posed as the "father of the Isthmian Canal" and thereby long held an influence which once appeared almost strong enough to lead the country into deplorable error. On his ultimate sacrifice of most of that influence and much of the respect and confidence in which he had been held it is needless to dwell. The names which will be linked in honor with the great enterprise are those of George B. Morison, who so ably demonstrated its physical advantages—of John C. Spooner, who carried to successful passage the act enabling the acquisition of the rights and property—and of John Hay, whose patient efforts negotiated the treaty giving the United States all needful territorial control.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

INTERURBAN ELECTRIC TRACTION.

THE DEVELOPMENT OF LOCAL TRAFFIC AND THE ABSORPTION OF PASSENGER AND MERCHANDISE BUSINESS OF STEAM RAILWAYS.

Practical Experience in Ohio.

THE question of the electrification of main-line railways, to use the awkward term which seems to have come into general use, has been discussed from various standpoints, the locomotive engineer having demonstrated to his own satisfaction that the amount of money locked up in steam machinery is a bar to the change, while the electrical engineer maintains that the steam locomotive is an early and universal candidate for the scrap heap. In the meantime the problem has been working out its own salvation in various parts of the world. In northern Italy the steam railways have found it advantageous to install electric lines to secure the local traffic which was slipping away from them, while in various parts of the United States the extension of trolley lines from one town to another in the more densely population districts has shown fairly well the scope and limitations of electric traction.

The experience which has been gained in Ohio forms the subject of discussion in recent papers in the *Railroad Gazette* and in the *Street Railway Journal,* and from the comparative data thus available some interesting conclusions may be drawn, with all the advantage which practical experience offers over the dogmatic expression of opinion.

In the northern part of Ohio, with the city of Cleveland as a centre, there are a number of city and suburban trolley lines which, after various financial vicissitudes, are begining to show stabilty, and to demonstrate their capacity both as to the creation of new traffic and as rivals to the established steam railways.

Starting as city tramways, the electric lines of northern Ohio have developed into interurban railways connecting with numerous well-populated towns within distances of 30 to 50 miles; and, running upon the line of the existing highways they have built up a local business which is both profitable and instructive. While much of this business is undoubtedly new, a large part of it is taken from the local service of the steam roads. This is shown by the falling off in short-haul passenger traffic of the steam railways. Thus the Lake Shore & Michigan Southern carried in 1895 an average of nearly 17,000 passengers per month in its local service between Cleveland and Oberlin, while in 1902 this had fallen to 7,600 per month. A still greater difference appears in the business between Cleveland and Painesville and intermediate points, the monthly average falling from 16,600 in 1895 to 2,400 in 1902.

The absence of suitable records for the electric lines prevent a critical comparison with the figures for the steam roads. At the same time the records do show that the traffic over the Cleveland, Elyria & Western system, has increased from 950,000 passengers in 1899 to about 3,000,000 in 1902, so that there can be no doubt as to where the missing short-haul traffic of the steam roads has gone.

In some instances the diversion has practically amounted to the total traffic on certain portions of the steam railways, tickets being purchased only when passengers need them for the purpose of checking baggage.

The question of fares has little or nothing to do with this remarkable change, since the difference is insufficient to make any such effect. The greater convenience of the terminal facilities of the electric cars gives them such an advantage that the steam roads make little or no attempt to compete, and admit frankly that they no longer have any real share in the interurban business within a radius of 10 to 15 miles of Cleveland.

The amount of business in an electric line which goes to the longer haul is difficult to determine precisely, and yet this is the exact portion of the question which measures the dividing line between the electric and the steam road. At the same time there are some general lines of information which indicate the limits. On the line between Cincinnati and Dayton, a distance of 57 miles, about 15 per cent. of the total business is through traffic, and the conditions are practically similar to those around Cleveland, and this may be taken as a fair estimate of the proportion of passengers who will be attracted by the lower rate of fare in spite of the greater time required for the journey.

It is very difficult to determine the amount of new business which has been created by the electric lines, especially in view of the frequent changes and reorganizations which have taken place since their installation. An idea may be obtained, however, from the fact that the total earnings of all the Cleveland traction lines has risen from $3,000,000 in 1896 to more than $6,275,000 in 1902.

The general effect of the development of interurban electric lines, running between large centres of population to good-sized towns within a radius of 30 to 50 miles, with their road bed on the side of highways passing through a well-occupied country, must be to divert the greater portion of the local traffic from the steam railways of the district. This is due very largely to the fact that the trolley car can be boarded at any point along the road and left at the place nearest to the rider's destination.

Many local travellers on steam roads have the inconvenience of passing close by their destination to a station several miles beyond, with no convenient means of connection, while the electric road, passing by the door, makes up in time more than the difference in actual running speed. The frequency of trolley service is also an important element in the question. When a certain train must be caught, as on the steam road, more or less time is always wasted in arranging one's affairs to fit the railway schedule, and frequently the inconvenience of a local railway time table far outweighs the greater speed of the train on the road.

An important feature of the interurban trolley lines is the transport of packages, this service being practicable at a lower cost and greater convenience than is possible on the steam railways. This again forms a department of business which has grown up almost independently of the steam railway freight and express traffic, since much of it consists of packages which would otherwise not have been sent at all. The whole work is in a line of industry largely of its own creating, and is an excellent confirmation of the adage that "facilities create traffic."

Viewed in the light of the experience which has been gained in the interurban electric systems of northern Ohio the relation of electric to steam traction may be fairly well determined. The steam railway will undoubtedly persist for a long time as the best and most economical method of handling long-distance business, say between points more than 100 miles apart. The local business can assuredly be conducted to better advantage, both for the carriers and the public, by the interurban electric railways, even as they are now operated, and when, with better road beds and more effective management a higher degree of efficiency is attained, we may expect to see the local trains to a great extent eliminated from the problem of steam railway operation. This cannot but conduce to far higher efficiency in the steam railway express service, and the advantages both for passenger and freight business of the longer haul will far more than compensate for the loss of the local traffic. When to this is added the impetus which the development of local industries must receive from the general advance in transport, it will be admitted that there will be a distinct gain, instead of a loss to the steam railways from the entrance of the interurban electric railway into the business of interurban transport.

RIVER-FLOW EXPERIMENTS.

AN EXPERIMENTAL TANK FOR THE STUDY OF THE ACTION OF CURRENTS IN THE FORMATION OF RIVER BEDS AND CHANNELS.

Engineering Laboratory at Karlsruhe.

MANY engineering problems contain so many variable elements that a satisfactory theoretical analysis cannot be effected without recourse to experimental determinations, and it is becoming more and more fully realised that the engineering laboratory is a necessary adjunct not only to the lecture room and study, but also to the investigation of the practical problems of the workshop and field.

The necessity of the testing tank for the investigation of the behaviour of ship models of various forms and speeds has been recognised by shipbuilders and governments, and now we have an extension of the experimental tank to the study of the action of currents in rivers as regards the erosion of banks and beds and the formation of shoals and channels.

A number of years ago the French engineers Darcy and Bazin employed a testing tank for the study of the flow of water in channels and over weirs, but their apparatus was arranged with an invariable slope, and without means for observing the action of the water upon the bottom and sides, and hence was available only for investigations of the velocity and discharge for a given slope. There has recently been constructed in the laboratory of the Polytechnic Institute at Karlsruhe, however, a very complete installation for the investigation of the action of the flowing water upon the channel, and from an account in a recent issue of *Le Génie Civil* and from the *Zeitschrift für Bauwesen* we abstract some account of the apparatus and its action. The tank, which is an improvement on one already built at Dresden, is made of sheet iron, and is 2 metres in width, 20 metres long, and 40 centimetres in depth, and is supported upon two girders in such a manner that its slope may be varied from zero to 1 in 50. In connection with the water supply there is arranged a rotary pump driven by electric motor so that a continuous supply of water may be kept flowing through the tank for any desired length of time, the discharge being returned to the suction of the pump.

The width of the tank is sufficient to permit the construction in sand of a channel of any desired sinuosity or curvature, the model stream or river bed being made of any desired width, and its banks formed of sand bags, or rammed sand, according to the nature of the experiments under consideration. In order to avoid the production of artificial currents in the miniature stream there is an arrangement of intercepting weirs at the delivery end of the tank by means of which all initial velocity is checked, and the flow of water is that due solely to the slope and volume, unaffected by any external influences. The water is delivered by the pump into an intermediate reservoir, from which it flows over a weir into the intercepting chambers at the head of the tank. The level of the water in the intermediate reservoir may be read at any time by means of a float and pointer, and from this level the discharge may be determined at any moment. A number of very precise determinations of the flow over the weir for various positions of the float have been made, and hence it is possible to observe the flow of water through the tank very accurately and to regulate it very closely at the rate determined for any desired experiment.

The manner in which a miniature river channel may be built up of sand is very clearly shown in some photographs which have been taken of the tank. By the use of sand of different degrees of coarseness the different kinds of soil may be imitated while dikes, breakwaters, and shore protection are built up of small bags containing leaden shot. The sand forming the river bed is smoothed off to a uniform depth before the water is turned on, and after the miniature river has been carefully filled with water the current is raised to the desired velocity and maintained for a sufficient period to enable the scouring action of the water to be observed. At the conclusion of an experiment the flow of water is stopped by shutting off the current simultaneously at both ends, and the stream is emptied by draining so slowly that the changes which have been made in the bed by the current are exposed without being disturbed.

The entire equipment of the apparatus is most complete, there being bins in the basement beneath for the storage of sand, with a power bucket elevator for lifting and delivering the sand into the tank; and the facilities for manipulating all the variable elements which enter into a test are arranged in a very convenient manner.

The researches which may be carried on in such an experimental tank are numerous and valuable. Thus, the scouring action of a current on the concave side of a curve may not only be demonstrated but the laws governing such action may be studied by varying the curvature, the rate of flow and the character of the material. The sustaining power of water at different velocities may be made the subject of experimental investigation and the rate of deposit and manner of distribution studied. These, and many other problems may be investigated in such a laboratory, and there is every reason to believe that such experiments may be the means of directing the expenditure of the large sums of money devoted to river and harbour improvement so that the best and most economical results may be obtained in the design and execution of such important and costly works.

In addition to the investigations upon the action of water upon the banks and beds of streams, for which the apparatus at Karlsruhe is primarily intended, it may be employed to great advantage for the purpose of supplementing the investigations of Darcy, Bazin, and others upon the flow of water in channels, especially with reference to the influence of the form and material of the bed upon the mean velocity. In spite of the numerous investigations which have been made upon stream flow these questions are yet in the empirical stage, and it is only by subjecting theoretical deductions to the ordeal of experimental test, that true rational relations can be discovered.

MUNICIPAL TRADING.

THE COST OF CONDUCTING INDUSTRIAL UNDERTAKINGS BY MUNICIPALITIES AS OPPOSED TO PRIVATE ENTERPRISES.

Dixon H. Davies—Society of Arts.

IT seems to be generally admitted that there are certain things the conduct of which naturally belongs to the people collectively, and certain others which may be done by individuals, by joint-stock companies, or by municipalities, as circumstances may dictate, but it is extremely difficult to determine the dividing lines between such undertakings. Thus in practically all civilised countries the national government is universally conceded to be the only proper body to coin money, maintain highways, and to carry written letters. In others the government has the monopoly of telegraphic communication as well, but this somehow does not seem to follow everywhere. The tobacco manufacture is held sacred to government in some places, while railways, lotteries, salt, alcohol, opium, etc., etc., are well-known examples.

So far as municipalities are concerned, the monopolies which are most generally conceded to them besides those relating to government and the maintaining of order are those of water-supply, lighting and the maintenance of highways, although in many instances the two former are delegated to private companies, generally under the form of leases. In Great Britain, however, there is an increasing tendency for municipalities to enter into various kinds of commercial undertakings, especially the business of electricity generation and distribution. The wisdom of such proceedings, although advocated by some, is doubted by many, and the whole subject has recently been discussed in a very interesting and instructive manner by Mr. Dixon H. Davies, in an address upon the cost of municipal trading, delivered before the Society of Arts, and published in the *Journal* of the Society.

In considering the motive which impels municipalities to attempt such undertakings Mr. Davies shows that it may be traced, not to civic patriotism, but, in nearly all cases to self-interest, and in this respect is not different from any other kind of trading. The desirability of this sort of thing is in any case very questionable even if it is practicable, and it is far safer to trust to traders to interpret the commercial demand of a community than to rely upon the discernment of officials or of governors. Apart from any such considerations, however, the practicability of developing certain industries as they should be permitted to grow involves operations of greater magnitude than most municipalities are capable of conducting. An example of this is seen in the early history of steam railways. Ten years elapsed between the construction of the Stockton and Darlington Railway and the more ambitious undertaking between Manchester and Liverpool. Doubtless it would have been quicker to have had the work done by the Manchester corporation at that time, but the present enormous development of railways, involving an investment not far short of twice the national debt, would never have been made in that way, and the growth of British railways would have been badly hampered had their progress been confined to the conditions surrounding the growth of electric tramways and interurban railways at the present time.

"The power of private enterprises to expand is limited only by the demand, and the demand serves as an automatic stimulus and check always proportioning it like the governor of a steam engine, so that it neither races nor lags. Governmental enterprise is without this automatic adjustment. Its command of funds does not depend upon the success or failure of its undertakings, but upon the credit of the ratepayers. Industrial advance is not secured by the average opinion, but by the original thought of one or two men who take a line of their own, and prove themselves to be right before the stern tribunal of the market."

A most objectionable attitude of municipalism is that which will not permit independent enterprise to do that which it is unequal to carry on itself. As a consequence there is a slow stifling of trade, not apparent at any one time, but gradually operating to the detriment of the nation. It is estimated that as much as £400,000 has been expended by municipal authorities between 1892 and 1898 in opposing private projects in Parliament. Mr. Davies very rightly says that he can perceive little difference in such action and that of the trades unions in picketing a works in time of labor difficulties. The corporations are performing precisely the same function as the pickets in that they are continually seeking to deprive men of the opportunity of working according to their own choice of employment.

The position of municipal corporations in the conduct of such a business as the supply of electricity, for instance, is such as to render it much less safe in its methods of management. Thus is may towns no allowance whatever is made for depreciation, while "profits" are freely appropriated. It is argued that the sinking fund is a sufficient provision, and that no further deduction need be made. The period of the sinking fund ranges, however, from 30 to 50 years, while electric machinery has often to be scrapped in eight or ten years if a power or tramway plant is to be kept up to date. As Mr. Davies well remarks: "To neglect to provide for this antiquation out of each year's revenue, is simply to cheat the ratepayer of to-morrow out of his just inheritance for the sake of keeping things pleasant with the ratepayer of to-day."

In reply to the argument that the municipal system offers the only escape from the dangers of the trusts, Mr. Davies calls attention to the fact that the trust has presented itself as a serious difficulty only in countries in which the industries are subject to protection, so that the consumer is practically confined to the internal markets which can be controlled by combinations of capitalists.

"It is the protective support of the law which enables the capitalist to oppress the consumer. It is not the power of capital, but the legal monopoly which is the seat of the evil. In Great Britain (if we perhaps except water) there is no reason why there should ever be any other monopoly than the monopoly of superior efficiency. A tramway down one street can be paralleled by a subway or tube down another street. Gas, which was at one time thought to be above competition, is now an alternative to electricity and petroleum. Hydraulic power has no monopoly. It shares its trade in many places with electric power, and in some also with pneumatic power supply. In private hands, the constant activity of invention, and the rivalry of commerce may be relied upon to secure in a free-trade country competition in one form or another, but the healthy stimulus and check of competition is always absent from an industry carried on by a municipal corporation."

The absence of control when the undertakings are in the hands of the corporations themselves appears in the absurdity of the borough authorities prosecuting the borough omnibus conductor, for instance, before the borough magistrate. The inconveniences of local boundaries and local jealousies are also cited as objections which disappear under competitive control, and altogether it is far easier to perceive objections than to discover advantages in the conduct of commercial undertakings by bodies originally derived for altogether different functions.

The great argument, that a corporation will have only the good of the citizen in view, while a company is run for the sake of making a profit, presumes that the two things are antagonistic to each other, while as a matter of fact the profit of the shareholders in a company is almost invariably secured by the charging of moderate prices in order to secure a large volume of business. Large profits are not obtained by charging high prices, but by wise management and by a large and satisfied clientele.

The proof of the disadvantages of municipal trading, however, lies in the slow progress of industries in Great Britain which, in other countries under the enterprise of private companies and active competition have attained phenomenal growth. Wherever open competition has been permitted, electric lighting, electric-power transmission, and electric traction have developed and prospered, and the communities have been correspondingly benefitted, but where, as in England, the industries have been checked and hindered by the incubus of municipal trading and municipal opposition, there has appeared a lack of progress which is entirely contradictory to British ability and British interests.

THE VIBRATIONS OF STEAMSHIPS.

AN EXHAUSTIVE STUDY OF SCIENTIFIC METHODS OF BALANCING MARINE ENGINES TO NEUTRALIZE THE VIBRATORY EFFECTS UPON THE HULL.

Rear-Admiral Melville, in Engineering.

WITH the great increases in speed and weight of marine engines there has arisen in late years a realisation of the necessity for providing, so far as possible, some satisfactory method of balancing the disturbing forces causing vibrations in the hulls of the vessels in which the machinery is placed. At one time the propeller was thought to be the chief source of vibratory disturbances, but the experiments of Yarrow upon a torpedo boat from which the screw had been removed, showed that by far the greater portion of the vibrations were due to the engines. The result has been a very general study of the possible methods of balancing marine engines, investigations having been made in England, Germany, and the United States which have been fruitful in practical developments.

In an exhaustive series of papers contributed by Rear Admiral George W. Melville, U. S. N., Engineer-in-Chief of the United States Navy to the pages of *Engineering*, the whole subject of balancing marine engines is discussed, together with a review of the work which has been done in the investigation of unbalanced or partially balanced engines in various parts of the world. Admiral Melville includes in his articles a study of the important papers which have appeared in Germany, including the investigations which have been undertaken by means of the Schlick pallograph, the whole forming a study of a problem which is of increasing importance in both the navy and the merchant marine.

As long ago as 1891 Naval Constructor D. W. Taylor, U. S. N., discussed the relation of the inertia forces and the crank angles, and showed that the unbalanced force of the first period, i. e., occurring in a single revolution of the engine, was represented by the closing line of a polygon, the sides of which were parallel to the cranks, and the lengths representing the inertia forces of the corresponding cranks. From this has grown the Yarrow-Schlick-Tweedy system of balancing, in which the cranks of a four-crank engine are placed at such angles that the polygon with sides corresponding to the corresponding inertia forces will close.

So far as the balancing of the first-period forces of a marine engine are concerned, this method enables satisfactory results to be attained, and it has been extensively applied in recent large engines, notably those of German design, including, among others, the engines of the transatlantic steamship Deutschland.

Many engineers appear to assume that if the first-period vibrations are fully taken care of the problem is satisfactorily solved but Admiral Melville maintains that the vibrations of higher periods may in many instances become of such magnitude and importance as to demand attention, and he holds that no system of balancing can be accepted as entirely satisfactory which does not provide for all the higher-period vibrations.

In order to show the existence and importance of the higher-period vibrations, Admiral Melville analyses a number of pallograms, or autographic records of hull vibrations, as recorded by the ingenious instrument, the pallograph, devised by Schlick, the German engineer, for the study of the subject. This instrument has been in regular use in the German navy since 1893, and the researches published by Imperial Naval Constructor Berling, Herr Mohr, and Naval Constructor Köhn von Jaski render a large amount of material available for the scientific investigation of the question. In studying these short-period vibrations Admiral Melville points out that the measure of their importance may be taken as the product of the force by the frequency, in which light some instructive facts are deduced. When the pallogram, or waved line drawn by the instrument under the influence of vibrations, is found to be a pure sine curve it represents vibrations of a single period. When, however, the waves depart from the sine curve, and show notches, crests, and hollows, it is evident that they are the resultants of vibrations of several periods, and it is possible to analyse the diagram and determine the simple elements of which it is composed. This Admiral Melville has done very effectively in his paper, to which the reader must be referred for the detailed analysis. It is sufficient to state here that in important examples the second period vibrations are found to be more important than those of the first period, and moreover the attempts to secure a balancing, by the Yarrow-Schlick-Tweedy system, of the first-period vibrations resulted in a marked increase in those of the second and higher periods.

Under these circumstances Admiral Melville does not accept the method of unequal crank angles, as advocated by Taylor, Schlick, and others, as the best method of balancing marine engines, but prefers the system of Macalpine, in which the two pistons of two cylinders are connected to opposite ends of a beam, the connecting rod being attached to one end of the beam and there being but two cranks for four cylinders. By this construction all the reciprocating forces may be neutralised by other equal forces acting in the opposite directions, while a moderate counterpoise on the crank enables the revolving weights to be balanced.

When it is admitted that the unequal angles of the cranks of the Yarrow-Schlick-Tweedy system do not effect a complete balance for vibrations of all periods, it is in order to examine the effect which the departure from cranks at right angles produces upon the turning moment upon the shaft. There has been a difference of opinion in this respect among naval engineers, but the best that can be said is that under certain circumstances the uniformity of the turning moment may not be seriously impaired by the departure from right-angled cranks. The torsional vibration period of the shaft enters into this portion of the problem, and the relation of the vibration of the shaft to the rotative speed of the engine must be considered. For the solution of this portion of the question both forms of engines may be proportioned without material advantage or disadvantage on either hand, so that the question of balancing engine vibration of all periods still remains the important feature. Certainly the arrangement of unequal crank angles is at no especial advantage in this respect, and since it has been shown to be defective as regards higher-period balancing it is the inferior method in any case.

Admiral Melville has given, in these important papers a fuller examination of one of the most important questions in marine engine design, than has been elsewhere available, and his views will doubtless be discussed in marine engineering circles on both sides of the Atlantic. Apart from the manner in which the problems under consideration are dealt with, however, his articles seem to furnish a most powerful argument for the abandonment of the reciprocating marine engine as soon as it can possibly be done. Higher speeds are demanded, and hence the evils of vibration must increase unless the steam turbine, in some form, can be made acceptable for marine use, and with the experience which has been had with smaller vessels it certainly seems as if larger applications might be made with safety and success. Prevention is certainly better than cure, and instead of providing methods for balancing the inertia forces of reciprocating parts those parts should be abandoned, and engines involving pure rotary motion only be introduced.

STEEL CASTINGS.

LARGE STEEL CASTINGS FOR ENGINEERING WORK AS EXEMPLIFIED IN THE WORK SHOWN AT THE DÜSSELDORF EXPOSITION.

Bernhard Osann—Stahl und Eisen.

WHILE cast iron has long been deemed unsuitable for situations in engineering structures in which great and varying stresses occur, the facility with which it can be formed into difficult and complicated shapes by the operation of melting and pouring into moulds has made its use general in situations to which the character of material is not altogether suited. With the development of the various processes for the manufacture of steel, however, many attempts have been made to unite the resistance and elasticity of steel with the ability to form it by casting in moulds, and at the present time many of the difficulties which were at first encountered have been overcome.

In an address recently delivered before the Eisenhütte Oberschlesien at Gleiwitz by Herr Bernhard Osann and published in *Stahl und Eisen,* the progress which has been made in recent years in the production of steel castings is discussed, the present state of the art being illustrated by the many important exhibits shown at Düsseldorf last year.

The earliest attempts at the productions of steel castings were made with crucible steel more than fifty years ago, and notwithstanding the development which has followed the introduction of the open-hearth process, crucible castings are still made for small articles. It is only during the past 10 or 15 years, however, that the commercial production of steel castings of large size has been fully developed, and to-day the work is confined to comparatively few establishments in which the necessary skill and experience have been acquired.

To the uninitiated the production of castings from steel may appear as simple a matter as the pouring of cast iron, but the materials are altogether different in behaviour. Much careful experimentation was necessary to enable a sufficiently soft material to be produced, and to make castings free from blowholes and shrinkage cracks involves great care and skill in the foundry. Herr Osann gives much credit to the Krupp works for the development of the steel casting industry, and calls attention to the fact that in the Krupp catalogue of 1887 announcement was made that the firm was prepared to furnish large castings of soft low steel having an ultimate resistance of 40 kilogrammes per square millimetre, with an extension of 20 per cent.

The manner in which the difficulties have been overcome, and the splendid work shown at Düsseldorf produced, Herr Osann discusses at length. So far as the quality of material is concerned, it depends largely upon the character of the pig iron from which the steel is made, the slightest traces only of phosphorus, sulphur, and copper being permissible. The tendency of soft material to form cooling cracks, owing to the great contraction on solidification, increases the difficulty in the production of perfect castings. Cooling cracks are not uncommon with soft cast iron, but the shrinkage of low steel is nearly double that of cast iron and hence the difficulties are much greater. The question of cooling and shrinkage is especially important in the case of large and intricate castings, such as the stern and rudder posts for screw steamships, large gear wheels, locomotive frames, and the like, examples of which were shown at Düsseldorf. The general employment of steel castings for pole pieces and armature rings for large dynamo-electric machines has made it necessary to produce pieces of difficult form, and in all of these the question of shrinkage cracks must be met.

To a large extent the designer can assist in providing satisfactory results. Shapes which would be entirely practicable in cast iron are altogether unsuited for casting in steel, since the junction of portions of greatly different volume and section causes such unequal contraction as to produce severe shrinkage strains.

The designer must understand the necessity of maintaining uniform sections of adjacent parts, or of merging one section gradually into another without abrupt changes or sharp angles. Where additional strength is required it should be obtained by the addition of ribs instead of increased general thickness, and the dimensions of some parts may be made greater than the requirements of mere strength in order to maintain fairly uniform thicknesses of metal in the casting.

The absence of cracks in the finished casting is by no means to be accepted as assurance of the absence of internal shrinkage stresses. It is altogether possible that some portions of the casting may be subjected, by reason of contraction, to internal stresses very nearly equal to the resistance of the material, so that fractures may appear upon the application of small external forces, especially shocks or blows. For this reason it is important that the casting should be annealed by raising it to such a temperature that the molecules may have an opportunity to rearrange themselves. Experience has shown that the annealing temperature is bounded by somewhat narrow limits, ranging between 800° and 900°C.

At the Krupp works the temperature is very carefully determined by the use of the Le Chatelier pyrometer, the annealing furnace being so arranged as to produce as nearly as possible a uniform temperature in all parts.

An important element in the production of perfect steel castings is the provision of an ample number of gates and vents in the mould, so that the casting may be poured at a large number of points at once and the flow of metal in the mould may be free and prompt.

If the mould it not rapidly and completely filled the thinner portions, webs, ribs, etc., will begin to solidify and contract before the thicker parts of the mould are filled, and even with the greatest promptness and rapidity of manipulation unequal cooling is apt to occur. A study of the cooling curves of the metal upon specimens of various thicknesses will enable the effect of the pouring to be observed and will permit the disposition and number of gates necessary to be determined.

It will be seen that a large part of the success attained by makers of steel castings is due, not to any especial process or material, but rather to the exercise of the greatest possible skill and judgment in the conduct of the work. Hard and fast rules and methods will not do, since each piece must be treated according to its peculiarities. That this can be accomplished within the limits of commercial success is shown by the extent to which steel castings are coming into use for important portions of machinery in which no risk of failure can be permitted. Herr Osann includes in his discussion sketches of sole plates and upright frames for marine engines, single castings weighing 3 and 4 metric tons, while rolling-mill castings of more than 25 tons have been successfully made. Pieces which could not be made of forgings because of the great expense involved, are readily produced in steel castings, and there is every reason to believe that with increasing experience both on the part of the designer and the steel founder, the employment of steel castings will be greatly extended in all departments of engineering construction.

PRACTICAL APPLICATIONS OF METALLOGRAPHY.

DETERMINATIONS OF THE PHYSICAL STRUCTURE OF STEEL IN CONNECTION WITH PROCESSES OF MANUFACTURE.

Albert Sauveur—Engineers' Society of Western Pennsylvania.

AMONG the many advances which have been made in the study of materials of construction one of the most recent is the application of the microscope to the examination of the physical structure of metals, the science of metallography, as it has been named after the analogy to the kindred science of petrography, the microscopic study of rocks. The general nature of the methods and results of the science of metallography were discussed by one of its leading exponents in America, Mr. Albert Sauveur in the issue of this Magazine for September, 1899, and now we have a lecture upon the subject by Mr. Sauveur, delivered before the Engineers' Society of Western Pennsylvania, and published in the *Proceedings* of the Society.

The practical man may well be excused for inquiring how the examination of a minute portion of the surface of a piece of iron or steel can convey any useful information as to its value for rails, or buildings, or machinery, and may be reasonably incredulous when he is assured that the study is eminently practical in its character.

At the same time Mr. Sauveur showed very plainly to an audience of intensely practical men, in the heart of the greatest steel producing centre of the world, that metallography must soon be allied with chemical analysis and the work of the testing machine in determining not only the character of their products after they are made, but also the best methods to be employed in the course of manufacture.

It is impracticable here to go into the details of the study of metallography, for these the reader must be referred to the papers of Mr. Sauveur and other specialists. Broadly, the method consists in polishing a small portion of the surface of the metal to be examined, so as to render it free from any surface markings or characteristics, and then treating this surface with acids or other substances, such as tincture of iodine, which etch or eat the various constituents to a different degree, rendering their occurrence and distribution visible. When such a polished and etched surface is examined under the microscope, the magnified portion shows to the experienced eye the arrangement of the particles of the metal in a manner which reveals many facts not otherwise ascertainable.

Thus steel, which the chemists can tell us only is composed of iron and carbon in certain proportions, is shown to exist with the iron and carbon arranged in different structural forms according, not only to their relative proportions, but also to the manner in which it has been subjected to the action of heat. The pure iron, or ferrite as it is called, is readily distinguishable when it occurs by itself. The carbon combined with iron as carbide appears in another form, known as cementite, while the mechanical mixture of the two, called pearlite, is also to be perceived by the eye. The relations between these important elements in steel, together with others of less conspicuous character, have much to do with the value and character of the steel as a material of construction, and if these relations can be determined by such simple operations as those of metallography, the practical bearing of that study becomes apparent.

Here the combination of microscopy and photography enters into the work, since it is possible to photograph the magnified images of the polished and etched sections so clearly as to enable comparisons to be made with any surface under examination and those which have been previously studied and photographed. This ability of preserving a permanent record of the result of any metallographical examination constitutes a valuable feature of the method, and one which should appeal to the practical man.

At the present time the microscopical examination is not available for the detection of the presence of phosphorus or sulphur, and hence it should be used in connection with chemical analysis, but this combination of the two methods of research enables far more to be learned than would be possible by the use of either separately. Thus

Mr. Sauveur showed a number of photographs taken from various portions of the section of a steel rail, showing very clearly the difference in structure in the different parts, although the chemical composition of the rail, considered as a whole, was doubtless within the limits prescribed by chemical requirements.

Mr. Sauveur discusses some of the objections which have been advanced in opposition to the introduction of metallography in the steel works, in a very effective manner.

"Many people argue that the knowledge of the structure of the metal is of little importance, and that if the metal is defective the testing machine will show it at once. To show how foolish this reasoning is, one might as well say that he does not care for a chemical analysis of steel, since if it be defective the physical test will demonstrate that fact. It is evident to every one that this is not the right view of the matter. The testing machine reveals the basic fact that the metal is defective without indicating the cause, much less suggesting a remedy. We want to know why it is defective. If it is defective, we want to know whether it is due to defective composition or to defective treatment, and the correct structure is just as important as the proper composition. It is just as important to know that a steel is not of too coarse a structure as it is to know that it does not contain too much phosphorus. The lack of ductility and the brittleness caused by a coarse crystallization is just as objectionable and is to be guarded against with just as much care as the brittleness caused by too high a percentage of phosphorus."

A very important feature in connection with the use of metallography in connection with steel manufacture is the extent to which it can be employed to check the heat treatment to which the metal has been subjected. Thus it is well known that rails should be rolled at a fairly definite temperature to obtain the most satisfactory results, but under ordinary circumstances it is very difficult to determine at what temperature a certain rail has been rolled. By making a microphotograph of the metal of the rail, however, and comparing it with a set of photographs of steel of the same composition taken at different temperatures it is possible to approximate very closely at any subsequent period to the temperature at which a given piece of steel was worked, and thus written records and verbal statements may be independently checked.

THE PHOTOMETRY OF ELECTRIC LAMPS.

EXISTING STANDARDS OF ILLUMINATING POWER, THEIR DEFECTS AND POSSIBILITIES, WITH SUGGESTIONS FOR IMPROVEMENT.

Dr. J. A. Fleming—Institution of Electrical Engineers.

ARTIFICIAL lighting has passed through almost as long a list of changes in the course of human history as any of the means by which man has converted the forces in Nature to his use and convenience, following closely behind the introduction of fire, with which, indeed it is still generally associated. It is not surprising, therefore, that some primitive ideas should still persist, even in the most scientific departments of its applications, and that the candle remains as a nominal standard of illumination. Now, however, it is beginning to be realised that something more precise than "candle power" is appropriate for the unit of measurement of light, and there have been numerous discussions in the past few years concerning the best methods of measuring, comparing, and recording the effects of illuminating appliances.

In a paper recently presented before the Institution of Electrical Engineers, Dr. J. A. Fleming discusses the whole subject in a very interesting manner, and some abstract of his address is here given.

Without attempting to consider the profound subject of photometry, every individual recognises the natural standard of daylight and mentally compares artificial lights with this standard. Instinctively one realises that a light possesses various qualities, and that the brightest light does not always furnish the most effective illumination or show true colour relations. Dr. Fleming considers these questions from the true scientific standpoint, showing the methods which are practically available, and including many valuable suggestions as to the establishment of standards of comparison and reference.

Considering first the question of standards, Dr. Fleming examines flame standards and incandescent standards, used both for reference and for working purposes. Of the flame standards the most important are the colza oil or Carcel standard, still used in France in practically the same form originally given to it by Dumas and Regnault; the Vernon-Harcourt pentane lamps, now the official standards for London gas testing; and the amyl-acetate lamp of Hefner-Alteneck, the legal standard of Germany. Of these Dr. Fleming considers the Vernon-Harcourt lamp the best, but believes that flame standards in general possess material disadvantages. In order to insure the uniformity necessary for a standard of light the greatest care is necessary to secure purity in the fuel burned, and during the photometric work the flame is affected by external variable conditions, such as the purity of the air, the barometric pressure, the action of draughts of air, etc. In the case of the Hefner-Alteneck lamp the reddish colour of the flame renders it unsuitable for use in heterochromatic photometry, or for the photometry of arc lamps. It is therefore extremely desirable that some other standard than that of a flame of any kind should be devised.

The standards of incandescence which have been used consist either of platinum or of carbon. The platinum standard of Violle involves the use of a unit of light consisting of the amount of light radiated normally from one square centimetre of platinum at its melting point. Although this unit has been the subject of adverse discussion, Dr. Fleming is disposed to accept it as an ultimate reference standard, providing satisfactory working standards can be derived from it. The experiments of Petavel have shown that the platinum standard can be made successful if the metal used is a mass of not less than 500 grammes, chemically pure, heated in a crucible of pure lime by an oxyhydrogen blowpipe, the hydrogen containing no hydro-carbons, there being a supply of three volumes of oxygen to four of hydrogen. The platinum is fused and then allowed to cool, and from the moment freezing commences until solidifiication is completed the light emitted is constant, being observed through an opening of one square centimetre in a water-cooled screen. Obviously such a standard is suited only for a physical laboratory, but may well be employed for standardising working standards of more convenient form.

For a working standard Dr. Fleming suggest a certain form of incandescent electric lamp, devised by him to remove the variability of the ordinary glow lamp. The ordinary incandescent filament increases somewhat in candle power for a short time, owing to changes in resistance, but after about 50 hours it becomes practically constant. The further deterioration in the illumination power of the lamp arises mainly from the deposit of particles of carbon upon the inside of the bulb, the blackening obstructing the passage of the light. Dr. Fleming has found that this blackening can be greatly reduced by the use of a much larger bulb, and hence he suggests as a convenient working standard an incandescent lamp of which the filament has been used in an ordinary bulb for about 50 hours, and then removed and placed in a large bulb. Such lamps, if used only for the short periods required in photometric work will maintain their constancy for a long time, when operated at the voltage for which they are marked. By using the Violle incandescent platinum standard as a reference for calibrating such standard glow lamps, therefore, a system of scientific photometric standards may be obtained which offers material advantages over those now in use.

Dr. Fleming discusses at length the different forms of photometers now in use and indicates his preference for the Lummer-Brodhun type, in which the lights from the two sources to be compared impinge upon opposite sides of a slab of white magnesia and are then reflected through prisms into a telescope where their intensities can be visually compared. In the use of this or of any form of photometer the necessity of excluding all external light is emphasised and the inadequacy of many existing arrangements pointed out.

When flame standards are employed especial care should be taken to have the photometer room well ventilated, and examples are given to show the effect which the presence of a number of persons in an imperfectly ventilated room had upon the uniformity of a Vernon-Harcourt pentane lamp.

The practical methods of setting out the polar curves showing the radiation of light from a lamp in different directions are described, and some very serviceable directions given as to the use of such information with respect to the setting out of lamps in street lighting. The important subject of photometric units is also discussed, and the suggestion is made that a convenient unit would be 10 candle power, to be called one lamp.

Dr. Fleming's paper is filled with useful and valuable information concerning the details of photometric work in connection with electric lighting, and it should be the cause of further discussion upon some of the subjects which he has agitated as demanding study and settlement.

THE GRADING OF PIG IRON.

CHEMICAL AND PHYSICAL TESTS AS COMPARED WITH GRADING BY FRACTURE IN THE SELECTION OF IRON FOR THE FOUNDRY.

Dr. Richard Moldenke—American Foundrymen's Association.

THE question of the strength and suitability of materials of engineering construction is being studied more and more, and the present tendency is to carry the practical investigation of materials back several stages beyond the state in which they enter into the completed structure. Thus the properties of the group of materials known under the generic name of steel have been traced back to the constituents of the pig iron, the furnace lining, the materials added in the converter or open-hearth furnace, the heat treatment, and other elements in its preparation and manufacture. In like manner the nature of cast-iron products is held to be largely dependent upon the character of the pig iron fed into the cupola, and this again upon the character of the ore, flux, and fuel delivered to the blast furnace. It has well been said that the raw material of one industry is the finished product of the other, and thus no product is entitled to be called raw from the moment that the hand of man has been laid upon it to apply it to any useful purpose.

The extensive use of cast iron in all departments of engineering work renders it especially important that definite results should be attained within reasonable limits concerning the strength and character of the products of the foundry cupola, and hence the necessity of grading the pig iron which forms the principal supply of material for the cupola has long been appreciated. The old method, that of grading pig iron by fracture, has been found unreliable, since the appearance of the fractured end of the pig is now known to be dependent upon the rate of cooling and other considerations besides quality and composition, and hence various methods have been suggested to permit a more accurate knowledge to be obtained.

This whole subject has been made the subject of extensive study by Dr. Richard Moldenke, and at the convention of the American Foundrymen's Association last summer he made a proposition to establish standard methods of foundry operation in order to obtain accurate information concerning the various elements which affect the character of the castings produced. We now have a second paper upon the subject by Dr. Moldenke in the *Journal of the American Foundrymen's Association,* discussing various elements in the valuation of pig iron for foundry purposes in an interesting manner.

It is now well established that chemical analysis is the most reliable method of determining the character of pig iron, and there appears to be a general willingness of dealers to sell pig iron by analysis. This is a great advance over the reliance upon brands and fractures formerly so general, but chemical analysis should not be the enter reliance of the foundryman.

Mr. Robert Buchanan, in his paper in the last issue of this Magazine, shows very forcibly the advantages of chemical analysis for the grading of pig iron over the old method of inspection of fracture which the foundryman thinks is sufficient.

"All the furnacemen on record think that selling pig iron by analysis is sufficient. They do not, however, realize that the roll maker, the founder of car wheels, the maker of malleable castings for specified tests, use several brands of the best irons obtainable, all of the proper composition, for safety; and when, in spite of this and the greatest care everywhere, the rolls crack, the car wheels fail to pass, and the couplers will not stand up, first one brand of iron is cut out and then another, and thus the hitherto unsuspected iron is weeded out. Doubtless this iron might be a very good one generally, but if the foundrymen had the means of knowing that his shipments were made while the furnace was under a cloud, he would rather give away the iron than put it into large rolls. Such irons, while showing the right composition, might be so badly burned in the making that normally strong pigs will break in two, by simply letting them fall on a rail. The cupola and the hearth furnaces are not the only places where iron can be badly oxidized, but this is very difficult to trace chemically."

When the strength of the castings is a matter of essential importance the chemical analysis should be suplemented by the physical test, made, not upon the pig, but upon standard test bars run from the cupola. Upon the combination of these two tests Dr. Moldenke thinks the ability to obtain standardized and reliable results depends. The chemical analysis shows what has been put into the cupola, and the results from the test bar reveal what has come out of it.

As regards the practical working of the physical test in addition to the chemical one, it will probably come about by the willingness of the founder who desires to have a guaranteed test strength to pay for it. This the founder of rolls, car wheels, malleables, government work, special machinery, and other castings requiring the highest grade of material will be glad to do. Wherever castings are made upon the strength and quality of which human life depends there should be no question of price in any case.

"It is further held that the physical strength is not enough, but that shrinkage, scrap carrying capacity, clean and sharp surface, and the microstructure of the iron should be arranged for. This I consider entirely too elaborate, and in fact unnecessary so far as we know now. The plain transverse test is all that is necessary to show what is required when taken in connection with the composition. The contraction of an iron when in the standard test bar, is practically a matter of its composition, and that mostly in the constitution of the carbons. With the large standard test bars, adopted by the American Foundrymen's Association, the influence of the pouring temperature and the molding sand is practically eliminated, leaving the question of contraction of much less importance than was formerly thought to be the case. Of course in the absence of chemical data a contraction test is very essential, but we are beyond that point at the present day.

The practice of selecting pig iron by chemical analysis and then checking the result by physical tests of the product, should, if systematically carried out, result in the collection of a large amount of valuable information concerning both iron and foundry practice. An iron which has given consistently good test results would reveal defective work in the foundry if the test bars began to make a poor showing, and conversely a variation in foundry practice might show means for improving the product of mixtures formerly misjudged. So much is dependent upon the maintenance of accurate records of sufficient experience that the main thing is to secure the adoption of some degree of standardization in order to secure records from which reliable conclusions may be drawn.

"It is admitted that poor foundry practice, bad fuel, or even variations in the regular routine will bring about variations in results with the best of irons, that the character of the castings made from pig iron depends upon many conditions, but the fundamental idea remains that with good standards and fair conditions, a good iron should show up well in a remelting test. What the actual strength should be will soon be developed by the foundryman most interested, and gradually pig irons, while varying in composition from month to month, or day to day, as they come from the furnace, will not vary as much in corresponding quality as they do now."

TESTS OF REINFORCED CONCRETE.

INFLUENCE OF THE DISTRIBUTION OF THE IMBEDDED METAL UPON THE STRENGTH OF REINFORCED-CONCRETE BEAMS.

Beton und Eisen.

ONE of many examples of the growing interest which is had in the use of reinforced concrete as a material of construction is the fact that a journal devoted entirely to the subject is now published in Vienna, the title being the significant one of *Beton und Eisen,* and the editor being the well-known engineer, Herr Fritz von Emperger. Although issued in Vienna, articles in this new journal appear in French and English as well as in German, in some instances papers appearing in more than one language simultaneously, in parallel columns.

In a recent issue of *Beton und Eisen* there appears several papers giving the results of tests upon beams of reinforced concrete, these showing very clearly the influence of the position of the metallic reinforcement with regard to the stresses upon the member.

Thus a series of tests were made in Holland by Sanders upon T beams of reinforced concrete, the heavier reinforcement being in the form of round rods imbedded longitudinally, and tied in to the body of the beam by means of lighter metallic stirrups. Tests were made upon two kinds of beams, the one having the flange uppermost and the other with the flange below, the rods in each case being imbedded in the lowermost portion. The dimensions of the beams were 300 millimetres deep by 200 millimetres wide, with a flange 500 millimetres wide and 60 millimetres thick, the length being 6 metres. The main reinforcement consisted of 4 round rods of steel of 20 mm. diameter, with stirrups and skeleton construction of rods of 4 to 8 mm. in diameter uniting these with the mass of the beam. The concrete was composed of 1 part of cement to 2 of sand and 2 of gravel, mixed rather wet, as is desirable for such work. and allowed to set and harden for two months prior to the testing. The tests were made by direct loading with pigs of iron, the load being uniformly distributed, and the deflections noted until rupture took place. The character of the ruptures is clearly shown by photographs, which indicate that failure took place in both types of beam by the crushing of the concrete the upper portion of the beam breaking down, and the light rods there imbedded buckling. Under such circumstances it is evident that greater strength would be obtained by increasing the section upon the compression side of the neutral axis, and that the beam which had its greatest section in that relation would prove the stronger. This view is confirmed by the tests, since the beam in which the flange was placed uppermost sustained a load of 13 metric tons before rupture, with a deflection of 37.5 millimetres, while with the flange below the rupture occurred with 10 ton, and at a deflection of 33.5 millimetre.s

In considering these tests it may be of interest to compare a series which were made at the Polytechnic School at Zürich by Professor Schüle, an account of which is given in the same issue of *Beton und Eisen.* These beams tested were reinforced according to the Hennebique system, with rods near both the top and bottom surfaces and with stirrups tying them into the body of the concrete. These were smaller than those tested by Sanders, being of rectangular section, 300 mm. high and 200 mm. thick, with a length between supports of 1.5 metre. The tests were made in an Amsler testing machine, the pressure being applied from a hydraulic plunger in the middle of the beam, and the deflections observed by a mirror apparatus of the Bauschinger type. The reinforcement in these beams consisted of four rods; of 15 mm. diameter in the upper portion and four in the lower portion, two of the rods in each portion running straight along the length of the beam, and two passing to the opposite surface and back again, thus acting as suspension members whichever edge of the beam was placed uppermost.

The object of the tests was to confirm, or otherwise, the relation of the deflection to the loading, in order to observe whether Hooke's law was maintained. Since the extension was demonstrated to increase made rapidly than the loads it became evident that the law of elasticity did not obtain, and hence the maximum efficiency of the material was not attained with the proportion or disposition of material.

It has been suggested that the true method of reinforcing concrete with imbedded metal should be that of distributing the reinforcement in the lines of tension as they exist in a beam subjected to the given loading. The locations of these lines are fairly well known, and indeed such a disposition of material was fairly well indicated in some of the earliest constructions in the original patents of Monier, as long ago as 1878.

The use of the methods of reinforced concrete for the manufacture of beams, to be transported to the place of erection and there employed much after the manner of beams of timber or metal appears to be a use of the system altogether aside from its principal characteristic advantage. The chief merit in the system really should lie in the ability to manufacture a structure on the spot which should, when completed be practically monolithic, the imbedded metal forming not only the reinforcement, but also the skeleton upon which to mould or pour the concrete. From this point of view, the experiments with beams may prove of interest and value as indicating the right proportions and disposition of material, but it should not be inferred that the formation of separate members for subsequent incorporation in structures at a distance is the best application of the methods.

MODERN GRINDING MACHINERY.

THE RIGHT USE OF GRINDING WHEELS IN MACHINE-SHOP PROCESSES—WORKING SURFACES AND SPEEDS.

Verein Deutscher Ingenieure—American Machinist.

GRINDING processes are now becoming so generally employed in the machine shop for finishing all kinds of metal surfaces that such work is beginning to demand as much attention as other methods of precise machining. Doubtless much of the accuracy and perfection of ground work depends upon the machines in which the wheels are used, but it is important that the right kind of wheels should be used, and that they should be operated at the proper speeds.

In a recent issue of the *American Machinist,* Mr. C. H. Norton gives some timely points about the use of grinding wheels, and in the *Zeitschrift des Vereines Deutscher Ingenieure* we note a report by Professor M. Grübler upon experiments recently made upon the strength of emery and carborundum wheels to resist the stresses due to centrifugal force.

Mr. Norton calls attention to the too common error of assuming that there is a proper lineal speed at the periphery at which the grinding surfaces of emery wheels should be run, and that therefore the rotative speed is governed entirely by the diameter of the wheel. Again, it is a common error to assume that to produce a fine finish the grain of the wheel must be as fine as that of the surface desired. As a matter of fact the character of the work produced is a resultant of several elements including grade of wheel, speed, depth of cut, speed of work, surface, etc., and all of these should be taken into account if the work is to be of the character desired and performed to the best advantage.

The idea that there are wheels so constructed that all materials can be ground equally well with one and the same wheel Mr. Norton aptly compares with the theory that is advertised by certain patent-medicine vendors, that one remedy can cure all human ills, and the two propositions are about equally far from the truth.

Wheels are constructed which will grind all materials, but as to grinding them all equally well, that is another question. When the proper wheels are used the work will be better done, time will be saved, and greater satisfaction attained. Many mechanics feel that the time required for changing wheels for various jobs will consume more time than will be saved by using the proper wheel, but Mr. Norton cites several examples to show that even for a single piece of work there is a time advantage in using the proper wheel, while if a number of pieces are to be ground the time of changing may become negligible. In this respect the grinding process should aid in systematising shop work, since the gain by classifying work so that a large lot of pieces of one kind are ready for grinding at one time, is a sufficient inducement to encourage the working of parts in lots, to the general gain of the passage of the whole through the works. When a wheel which is unsuited for the work is employed the truth of the surface may be materially affected. Thus if a coarse, rapid-grinding wheel, suitable for use on cast iron be used for soft steel on light work the pieces will be very apt to be ground out of truth, the frail work not being able to stand the rank cut of the soft wheel on the soft material. A harder and more compact wheel will then not only do the work better, but perform it in less time as well.

The most important point brought out by Mr. Norton is the fact that grinding should be considered as a special and precise shop process, and as such should be given the same special care and supervision as is now demanded for every machining process in the well conducted modern machine shop. In other words, the man who tends the machine should have nothing to say whatever about the character of wheel, its speed, or the manner in which it should be used. All these questions should be under the care of a single expert, whose duty it should be to direct the use of the wheels, and see that they are properly employed in the same manner that the tool-maker in the modern shop attends to the automatic screw machines, turret lathes, and other standard cutting tools. The machinist should find his work in attending to the running of the machines, not in grinding tools and setting them to the especial angle which may suit his fancy, this latter work being done in the tool room according to carefully predetermined methods, and taken out of his hands altogether. The same should be true of the grinding wheels, and when such skilled supervision is given to the right use of the grinding machinery the time required to perform each piece of work can be determined and allotted to the machinist for any bonus, premium, or piece work system which may be adopted, with the assurance on the part of the employer and the workman alike that it is fully within the capacity of the machine.

The paper of Professor Grübler discusses a number of experiments made upon wheels of various kinds, in order to ascertain the resistance to bursting. The apparatus, which shows much ingenuity in design, consisted of a vertical spindle running in bearings supported upon beams over a pit, the wheel being placed on the end of the spindle suspended at a sufficient depth in the pit to prevent any possibility of accident from flying pieces of bursting wheels. An accurately calibrated speed indicator was connected to the upper end of the spindle, this enabling the speed at any moment to be observed, while at the same time a permanent speed record was made, the two checking each other within small limits of error. The spindle was revolved by rope connection to a four horse power electric motor, with suitable switchboard appliances, the whole being entirely under control of the experimenter.

A number of wheels were tested to destruction in this apparatus the data and results being fully tabulated in the original report, and some general conclusions only are here given. The wheels tested were divided into three classes, according to the character of the binding material by which the abrasive was cemented into form. These included compositions using a vegetable binding, usually some kind of gum; or a mineral binding, principally magnesia cement; or a ceramic composition, similar to a porcelain, the moulded wheel being subjected to a white heat. The only wheel not coming under this classification is that made by the Tanite company, in which an animal binding is employed, made from leather residues.

So far as rated speeds were concerned the makers of the wheels using a vegetable binding offered the highest, one firm permiting peripheral speeds of 25 metres per second (4,920 feet per second) while wheels with a .mineral binding were rated at a maximum speed of 15 metres per second, (2,952 feet per minute). As a matter of fact, however, both kinds of bindings showed high resistances in the tests, the bursting speeds ranging from 70 to 110 metres per second (13,776 ft. to 21,648 ft. per minute).

The highest bursting speed tabulated by Professor Grübler was that attained by a carborundum wheel, with a ceramic binding, this bursting at a peripheral speed of 114.21 metres per second (22,476 feet per minute).

Professor Grübler's paper contains much valuable information concerning the conditions upon which the strength of grinding wheels depend, and not the least interesting of the results of the tests is the general high character of the wheels tested, representing prominent German and American makers. With wheels properly mounted there should be no hesitation about running them at speeds indicated by their makers, so far as bursting resistance is concerned, and hence the question of speed may be decided by conditions of efficiency governed by the nature of the work.

THE MERCURY-VAPOR TUBE.

EXTENDING APPLICATIONS OF THE COOPER-HEWITT MERCURY-VAPOR TUBE AS A CURRENT RECTIFIER AND INTERRUPTER.

Electrical Review.

THE mercury-vapor lamp of Mr. Peter Cooper Hewitt is well known as a successful device for obtaining illumination from the electric current with a much lower expenditure of electrical energy than has been attained with the incandescent glow lamp. The device consists of a glass tube of any shape which may be desired, provided with a bulb at one end filled with mercury. The tube is exhausted of air, a negative electrode fixed in the mercury-bulb end, and a positive electrode at the other end. Upon the passage of a continuous current the tube, filled with mercury vapor, emits a brilliant light, and tests have shown that the consumption of electrical energy is only about one-seventh that required to produce an equivalent illumination with the ordinary incandescent lamp. The principal objection which has been advanced to the mercury-vapor lamp is the absence of red rays, this giving a peculiar aspect to everything in which that color should appear, but the absence of these rays removes a source of irritation to the human eye, and hence this defect is not altogether objectionable.

Upon experimenting with this lamp the principal working problem appeared to lie in the fact that the high resistance to the passage of the current required the use of some special device to break down the initial resistance and permit the flow of the current, since this flow can be readily maintained after the initial resistance has been overcome. Experiments along this line have resulted in revealing the great value of the mercury-vapor tube for other purposes than those of illumination. From recent papers in the *Electrical Review* we abstract some discussion of the use of the tube, or bulb, as a rectifier of alternating currents, and also as an interrupter for the production of Hertzian waves for use in space telegraphy.

The use of the device as a rectifier depends upon the fact that the mercury vapor permits the passage of a current in one direction only, and as already described, the negative electrode being in the mercury bulb, and the positive at the other end, the current flows from the upper end of the tube down to the end containing the mercury.

When an alternating current is used instead of a continuous one, only the positive portions of the waves pass, the negative ones being checked, and hence a succession of pulsations are passed. If a polyphase current is employed, it is only necessary to have as many positive electrodes at the upper portion of the bulb as there are phases to the current, with but a single negative electrode below, together with a starting positive electrode in connection with the other positive connections. The result is a succession of positive pulsations, constituting practically a continuous current, derived from the polyphase current by the interposition of a simple piece of apparatus without moving parts. The efficiency of the apparatus is dependent upon the voltage of the current to be transformed, since it appears that the loss in the transformer is about 14 volts at all times, so that with a current of 140 volts the loss would be 10 per cent., and with a current of 1,400 volts, only 1 per cent. The loss appears as heat, the mercury being vaporized and condensed upon the interior surface of the tube.

While it is too soon to be sure of the industrial applications of such a current rectifier, it offers large possibilities, when the size and cost of the present rotary converters are taken into account. In its present form it is adapted for the charging of storage batteries, and there is little doubt that it will be rendered available for other and more extensive applications.

The use of the mercury tube as an interrupter also follows as a consequence of the initial resistance of the mercury vapor to the passage of the current, and includes the fact that when the resistance has been overcome, it will reappear again when the potential is allowed to fall. For this purpose the mercury tube is arranged in connection with condensers in such a manner as to produce a succession of discharges across the tube, the latter forming an interrupter of low resistance and ready controllability.

With all the improvements which have recently been made in the receiving apparatus of space telegraphy there has been little or nothing done to advance the method of producing the impulses at the transmitting end.

This is in marked contrast to the development which has been seen in the receiving apparatus, the coherer of Branly and Lodge having been followed by the mercury drop of Solari and by the magnetic detection of Marconi, each rendering the reception of the message more certain and rapid than was possible with its predecessor, so that until now the transmitting apparatus has remained unimproved.

"The method now employed to set up oscillations in the sending circuit of a wireless telegraph station consists of a discharge of condensers across an air-gap; but this method gives rise to oscillatory discharges of such a character that it is practically impossible to tune a receiver to them, and since the resistance of the spark-gap is high, the power which may in this way be radiated is comparatively small. The Cooper Hewitt mercury vapor interrupter, however, gives continuous impulses of equal amplitude. The frequency of these will be predetermined precisely by the constants of the circuit, so that selective telegraphy will not only be possible, but easy. That is to say, there will be no difficulty in tuning a receiving circuit to respond to a given frequency."

Experiments which have been made with the mercury-vapor interrupter show that it is eminently adapted to be used as a transmitter for space telegraphy, and a comparison with a spark-gap interrupter demonstrated the great increase in discharge which the new interrupter made possible.

"Many attempts have been made to produce an effective high-speed interrupter which would have a reasonable life. Up to this time the discharge-gap between polished metal spheres has been most satisfactory, but it is far from perfect. In the first place, a spark-gap operating in air is too slow, owing to its resistance and to the character of the discharge across it. The effectiveness of the spark-gap in air is increased by using large metal spheres having polished surfaces, but the surfaces of these are rapidly destroyed by the current. That they are inefficient is proved by the rapidity with which they become heated if the discharge is of any considerable magnitude. The Cooper-Hewitt mercury vapor interrupter, on the other hand, seems to be free from all these defects. When a certain difference of potential between the terminals of the interrupter has been reached, the initial negative electrode resistance practically disappears, and the rapidity with which the discharge can take place depends only upon the capacity and the inductance of the circuit. In other words, the condenser charges and discharges at a definite frequency, determined by the circuit, and the source of supply. Discharges that will re-enforce the oscillations before their decay are far more effective in producing the desired electrical effects in a suitable circuit than the irregular discharges of an ordinary spark-gap."

The mercury-vapor tube, therefore, appears to have developed three distinct functions, all of them important, and yet each relating to a different department of electrical work, including lighting, transformation, and wave transmission. Which of these may develop into the most important, time will tell, but it is not often that such a simple device proves capable of producing such far-reaching effects.

THE STEAM TURBINE.

A STUDY OF THE PROBABLE DEVELOPMENT OF THE STEAM ENGINE IN THE LIGHT OF EXPERIENCE WITH THE STEAM TURBINE.

Professor Stodola— Verein Deutscher Ingenieure.

AMONG the subjects discussed at the Düsseldorf meeting of the Verein Deutscher Ingenieure there was presented a paper upon the steam turbine by Professor Stodola which treated of the subject in a thoroughly scientific manner. This paper has since ben expanded by the author into an exhaustive treatise upon the whole subject of the use of steam in turbo-motors, examining the thermodynamics of the subject, and discussing the probable effect of the introduction of such machines upon the future of steam engine design, the whole appearing as a serial in the pages of the *Zeitscrift des Vereines Deutscher Ingenieure.* It is possible here to give only a brief abstract of this important contribution to the literature of steam engineering, but a general idea of the treatment may be given as indicating the scope of the subject.

Remarking, in the first place, upon the fact that the idea of using the impact of a jet of steam to drive a revolving wheel is a very old one, Professor Stodola calls attention to the fact that such machines have become possible in a practical sense only with the improvements in machine construction, enabling the accurate fitting and high rotative speeds to be dealt with successfully. In addition to this general condition there have been other good reasons why the development of the steam turbine has been delayed until the present time, such as a lack of knowledge of the action of steam jets, together with a tardy appreciation of the methods of balancing, and the prevention of excessive vibration.

Professor Stodola takes up the problems to be dealt with in order, discussing the thermodynamics of steam jets, the mechanical question of high-speed construction, and the prevention of vibration, in the order named, concluding with an account of existing machines, with suggestions for future designs.

In considering the conversion of heat into mechanical energy by the use of jets of steam it is necessary to examine into the possible sources of loss, these being found mainly in the frictional resistance to the flow and the losses in eddying, and by assuming an adiabatic flow, in which heat is neither supplied or lost it is possible to show the development of mechanical energy from heat in the form of a temperature-entropy diagram directly by measuring the fall of temperature with the performance of work. A general form of diagram, adapted especially for the study of the flow of steam under the conditions existing in steam turbines is given, based on the method of Professor Mollier, and by its use the thermodynamics of steam jets may be examined in a very satisfactory manner.

The mechanical action of such jets, including the phenomena of impact require examination, and an important portion of Professor Stodola's paper is devoted to this portion of the subject the pressures developed upon the buckets of the turbine being shown graphically, and the relation to the form of buckets discussed. An ingenious apparatus for the measurement of the pressure upon stationary buckets of various forms was devised for use in these researches, the data thus being derived originally for this discussion.

In regard to the mechanical construction of the revolving member of a turbine the question of resistance to the centrifugal force becomes an important element at the high rotative speeds necessary to obtain the highest mechanical efficiency. For wheels of the De Laval type the section of the disc is made that of a body of uniform strength, and a comparison between this and a disc of uniform thickness shows the gain in strength obtained by the scientific distribution of material.

The question of balancing and the prevention of vibrations is examined mathematically, and the effect of the departure, even in the smallest degree, of the centre of gravity from the axis of rotation is fully shown. Since it is practically impossible to secure perfect balance, the importance of the flexible shaft, as used by De Laval, appears, this enabling the disc to place itself in the axis of rotation without producing severe stresses in the shaft or its bearings. The subject of the critical speed is developed mathematically, and the entire problem of dealing with satisfactory mechanical construction at extremely high speeds is examined very thoroughly.

Passing from the theory to the practical work which has been already done, Professor Stodola examines the different machines, classifying them according as the expansion of the steam is conducted in one or several stages. In this portion of the paper some practical methods are given for determining the angles of the buckets, and proportioning the various parts of a machine according to the variable elements which can be controlled. The advantages of the disc turbine of the De Laval type for single expansion are shown, and the effective manner in which the axial turbine of the Parsons type is adapted for multiple expansion appears. An interesting machine is the Zoelly turbine, in which a number of discs, modified from the De Laval form, are used to obtain successive expansions, this form enabling a high efficiency to be secured without the extremely high rotative speed required for the De Laval machine in its simple form.

The paper contains data and results of a number of tests of turbines in Europe and America, steam consumptions as low as 14 pounds per brake horse power being obtained at Elberfeld with a Parsons turbine, a result which is as good as could be expected from a reciprocating engine under similar conditions.

So far as the commercial development of the steam turbine is concerned, Professor Stodola calls attention to the fact that in Europe already there has been built about 90,000 horse power of the De Laval turbine, and about half as much power of Parsons's type. The firm of Brown, Boveri & Co., in Switzerland, has constructed 16,000 horse power, while in America the Westinghouse Company has constructed 40,000 horse power of Parsons turbines. The Rateau turbine is already being manufactured on a commercial scale, and numerous other designs are being prepared and developed. Already units as high as 5,000 horse power have been successfully constructed, and there is every evidence that the mechanical and commercial difficulties have been practically surmounted. The influence of this activity upon the general course of steam engine design may well be a subject for serious consideration. The advantages of high speed have already been appreciated, even with the difficulties which high speeds involve with reciprocating engines, but with all the reciprocating movements abandoned, and with direct-connected electrical generators, including electrical distribution and regulation, there is every reason to expect a transformation in steam power plants which will render what are now considered the finest examples of steam engineering, candidates for the scrap heap and the museum.

THE TAYLOR-WHITE TOOL STEEL.

PROCESSES OF TREATING TOOL STEELS TO OBTAIN MAXIMUM EFFICIENCY AT HIGH CUTTING SPEEDS.

Report of the Franklin Institute.

ALTHOUGH modern high-speed tool steels have been extensively discussed in the technical press for the past two years, the information about them has lacked that definiteness which is desirable upon such an important subject. In Germany the Society of German Engineers has made some investigations, and papers have been read before technical societies, but now we have the report of the sub-committee of the Franklin Institute, appointed to examine and report upon the Taylor-White steel with a view of its eligibility for award of some one of the honors in the control of the Institute, and from this report published in the *Journal* of the Institute, we make some abstracts. When it is understood that the sub-committee included among its members such well-known engineers as Dr. Coleman Sellers, Mr. James Christie, and Mr. Wilfred Lewis, the nature and character of the investigation will be seen.

The improvements in modern tool steels may be said to have originated in an investigation of such steels undertaken about three years ago at the works of the Bethlehem Steel Company. At that time the only steels under consideration were the usual carbon tool steel, and the air or self-hardening steel of Mushet. The Mushet steel had almost entirely replaced the carbon steel for roughing purposes, its efficiency being about 50 per cent. higher than carbon steel when used to the best advantage. This was due to the fact that Mushet discovered by reason of the addition of manganese and tungsten to tool-steel that is was possible to maintain a cutting edge at a much higher temperature than otherwise, this permitting the employment of higher cutting speeds. At the same time the results obtained with Mushet steel varied greatly at different times, and hence the experiments referred to above were undertaken to determine, if possible, the influence of variations in the process of hardening upon the product.

Up to the time of these investigations it was the practice to harden all air-hardening steels by heating to a cherry-red and either allowing to cool gradually or in a blast of air. Users were invariably cautioned against overheating, cherry-red being specified indicating as the correct temperature.

The tests undertaken to investigate the effect of various hardening temperatures consisted in the forging of a number of tools of a certain brand of steel and heating them to different temperatures, these tools then being tested in a special lathe arranged for heavy work provided with means for a gradual regulation of speeds throughout a wide range. The results revealed the remarkable fact that while it is true that tools made of air-hardening steels all deteriorate at temperatures in excess of a bright cherry, it is also true that when air-hardening steels are made with certain constituents in ascertained proportions this deterioration prevails only during a limited range of temperatures above the bright cherry red; that is, from about 1,550°F. to about 1,700°F., while above this latter temperature to about 2,000°F. the efficiency of such steels is greatly increased. The special constituents in ascertained proportions to which reference has been made are about one-half of 1 per cent. of chromium and at least 1 per cent. of tungsten or molybdenum, there being various modifications of these proportions described in the Taylor-White patents. The elements affecting the steel appear to be all members of the chromium group, tungsten and molybdenum being those commercially available. The percentage of carbon appears to have little or no effect on the results, steels containing from 85°C. to 200°C. having the same efficiency.

In connection with the use of these higher hardening temperatures the method of cooling is modified, the tool being cooled rapidly from the high heat to a point below the breaking-down temperature, about 1,700°F., in a lead bath, then slowly in air or lime.

It is essential that at no time should the temperature rise, as in such case the tool would be seriously impaired. The importance of the heating and cooling operations has led Messrs. Taylor and White to devise apparatus for attaining the proper temperatures very closely, this conducing to the uniformity of the product.

The report of the committee includes experiments made by them upon a large number of other tool steels in the market at the time of the original production of the Taylor-White steel, the results of these tests being tabulated in the report. These tests were made upon hammered forgings of steel, upon soft steel forgings, and upon cast iron. The results showed that the relative efficiency of the treated tool and the best untreated tool was 11 to 3, or more than 3.5 to 1 for the hard forging, while for the soft forging it was 156 to 70, or 2.2 to 1, and for cast iron 70 to 55, or about 1.3 to 1.

This shows that for steel the efficiency is much greater for hard forgings than for soft, but even in the latter case it exceeds two to one, while, as might be expected, the saving on cast iron is much less, being about 1¼ to 1.

The great peculiarity about the steel, as is well known, is its ability to maintain the cutting edge uninjured even when operated at a red heat. Thus a tool cutting with a red heat maintained 5/16 from the point for a period of twenty minutes, was afterwards examined with a magnifying glass and the original grinding marks were still visible.

The report emphasises the fact that such a steel is valuable only for roughing purposes, and unless used at sufficient speeds to remove large quantities of material no gain need be expected from its use. Thus attempts have been made to use such steels for finishing cuts on light work with the natural result that there was not sufficient mass of metal in the work to carry away the heat, and the *work,* not the tool, failed under the test. For such purposes there is no advantage in using the high-speed steel, and tests made under such conditions are necessarily misleading.

Having such a high-speed steel the question as to its real value in machine shop processes remains to be considered, although this feature was but touched upon on the committee's report. This is a matter of shop practice altogether. To put on large quantities of metal for the sake of using extraordinarily powerful tools and improved steels for the fun of cutting it off again may seem to be rather doubtful policy, but it must be remembered that there is a large gain at the other end of the line, namely, in the making of the forging. To forge closely to size, especially in heavy work, is a slow and expensive operation. In modern work every saving in time is understood to count for economy in a double sense, saving both the labor cost of the productive workmen, and cutting down the proportion of establishment charges to be borne by the work. In view of such fields for economy the cost of the material is insignificant, especially as the material is not wholly lost, but goes again to the furnace to reappear in succeeding work. The advantages of saving in time was long ago realized in the introduction of the bolt-cutting machine, in which it was demonstrated to be far more economical to cut the round body of the bolt down from hexagon bars of the size of the bolt head than to forge hexagon heads on to round iron.

The high-speed steel applies this principle to general work, on a far larger scale, saving the expensive work at the forge on the heaviest work to shape the finished piece at a vastly increased speed in the machine shop. The increased capacity of the shop also counts heavily in the economy in capital account, since extensions and increase in buildings and plant are avoided by the increase in the productive capacity of existing installations.

The influence of the new steels upon machine tool design forms another important element in the question, but this will be found ably treated by Mr. Oberlin Smith in another place in this issue.

THE ACTION OF PUMPS.

EXPERIMENTS UPON THE BEHAVIOUR OF WATER IN PASSING THROUGH PUMPING MACHINERY —MOMENTUM AND INERTIA EFFECTS.

Institution of Mechanical Engineers.

AT a recent meeting of the Institution of Mechanical Engineers there was presented a paper by Professor John Goodman, giving data and results of certain tests made by him upon a plunger pump, with an interesting discussion upon the phenomena observed, and some abstract of the discussion is here given.

As Professor Goodman well remarks, the action of a pump is by no means the simple thing which it appears upon inspection, forces and actions being set up which require explanation and regulation.

In order to study the behaviour of the water in the course of its passage through the various parts of a pump, Professor Goodman undertook in the engineering laboratory of Yorkshire College, Leeds, a series of experiments upon a plunger pump of moderate size, equipped with various devices to enable the various actions to be observed and recorded. The pump was arranged to be driven either by its own steam cylinder or by a belt, a speed indicator showing the velocity, the water delivered was measured over a V weir, and indicators were placed on the pump barrel steam cylinder, delivery pipe and suction pipe so as to enable the actual pressures to be recorded at all these points simultaneously. The suction pipe was connected so that its length could be made either 36 or 63 feet, while various changes could be made in the water valves and air chamber.

The experiments were conducted for the purpose of finding out how the slip, or discharge coefficient, as well as the water hammer on the suction pipe, were affected by variations in delivery pressure, changes in speed, alterations in length of suction pipe, and removal of suction valve. The tests were also intended to show the behaviour of the valves, the speed at which cavitation, or separation of the suction column occurs, and the general conditions affecting the efficiency of the pump considered as a machine. The details of the experiments are described in the paper, together with reproductions of indicator diagrams, showing the manner in which the pressures were recorded, and the whole investigation appears to have been conducted in a manner which should inspire confidence in the results and conclusions.

Considering the slip of a pump it is usual to consider that the volume of water pumped is from 95 to 100 per cent. of the plunger displacement, the loss being due to leakage and the presence of small quantities of air. In a few isolated instances a negative slip has been observed,the delivery being greater than the plunger displacement, and Professor Goodman's experiments show the conditions under which this action occurs, and indicate the manner by which it may be computed.

For moderate speeds, the experiments showed that the delivery was about 94 per cent. of the plunger displacement, a result quite in accordance with experience elsewhere, but at higher speeds pounding and hammer blow occurred, the hydraulic-ram action of the water in the suction pipe carrying it past the suction and discharge valves and increasing the delivery to amounts of more than 50 per cent. in excess of the plunger displacement. Of course the actual amount of work performed in no case exceeded the indicated work done in the pump barrel, the increased friction, in fact, making it less than when there was no such negative slip. The indicated horse power in the steam cylinder and the power calculated from the pressure in the pump barrel and the quantity of water passing over the weir agreed very closely in all cases, so that the negative slip was in all instances an injurious effect.

The indicator diagrams taken from the pump valves show that their action, when uncontrolled, is by no means so simple as has sometimes been supposed, and that their movements are correct only on low speeds and when delivering against a moderate head. The velocity of water through such valves should not exceed about two feet per second. The banging which is often heard in the suction pipes of pumps is shown to be due to the separation of the plunger from the water and their subsequent meeting. This action can be prevented by the use of a suitable air chamber on the suction pipe close to the pump, by reducing the velocity of the water, or by using a shorter suction pipe.

When such modifications cannot be made the proper remedy is that pointed out by Professor Riedler as a result of his extensive researches on pumping machinery; namely the use of mechanically operated valves. Such valves have the double advantage that their opening and closing can be positively determined and modified, and that high lifts and large openings may be given without involving heavy blows of the valves upon their seats. The added complication of the valve gear may be offset by the fact that single large valves may be used where otherwise several smaller ones would have become necessary.

The great convenience of using electric driving for pumping machinery is becoming generally appreciated, especially for mining work and for other locations in which the transmission of power by steam or compressed air is unsatisfactory. For such driving, however, the high speed of the motors requires the introduction of high-speed pumps, otherwise reduction gearing or similar devices must be employed. These considerations, together with the small size and light weight of high-speed pumps render it especially desirable that their action under such working conditions be thoroughly understood, and that the causes of defective action and noisy working at high speeds be eliminated.

Professor Goodman's paper is an excellent example of the manner in which useful research work may be performed in a college laboratory, affording instruction in methods of investigation and at the same time rendering permanent services to the practical work of machine construction.

THE ENGINEERING INDEX

"THE ENGINEERING INDEX IS THE KEYSTONE OF APPLIED SCIENCE"

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world,—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arch.

A Graphical Investigation of the Elastic Circular Arch (Graphostatische Untersuchung des Elastichen Kreisbogengewölbes). Josef Schreier. An exhaustive study of the segmental arch according to the methods of graphostatics, with plate of diagrams. 4500 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Feb. 6, 1903. No. 53725 B.

Chicago.

Bridges Over the Chicago Ship Canal. Diagram showing the position of the 28 drawbridges, with brief description of each. 800 w. R R Gaz—Feb. 20, 1903. No. 53653.

Culvert.

A Concrete-Steel Culvert for Stream Diversion at Kalamazoo, Mich. George S. Pierson. A statement of the conditions and an illustrated description of the work. 2100 w. Eng News—Feb. 12, 1903. No. 53543.

Drawbridge.

Wood Block Paving and Other Features in Connection with a Small Drawbridge in Brooklyn, N. Y. Illustrated description of a bridge for heavy traffic. 1000 w. Eng Rec—Feb. 7, 1903. No. 53503.

We supply copies of these articles. See page 157.

Foot-Bridge.

Monier Footbridge Over the Coblenz-Treves Railway (Fussweg Uberfuhrung in Monier Konstruktion auf der Linie Koblenz-Trier). Illustrated description of a light and effective arch bridge in reinforced concrete on the Monier system. 1000 w. Deutsche Bauzeitung—Jan. 14, 1903. No. 53750 B.

New York.

The Manhattan Bridge, New York. Illustrates some of the main features of Bridge No. 3, which will connect Canal St., New York, with Fulton St., Brooklyn, with description. 1200 w. Eng Rec—Feb. 21, 1903. No. 53837.

Quebec.

The Substructure for the 1800-ft. Cantilever Bridge at Quebec, Canada. Illustrated description of the substructure and foundations of the longest span bridge in the world, now in process of construction across the St. Lawrence River. 6000 w. Eng News—Jan. 29, 1903. No. 53309.

Viaduct.

The Approach to the Pennsylvania Railroad Bridge at Fifty-second Street, Philadelphia. Detailed description of bridge and approaches of this important improvement. Ill. 2400 w. Eng Rec—Feb. 14, 1903. No. 53636.

CANALS, RIVERS & HARBORS.

Dredging.

Bucket, Suction, and Pressure Dredge (Selbstadener Ernier Druck und Sangbagger). A description of the new dredge built by Conrad, of Haarlem, Holland, for the Russian government for the harbor of Riga. 1000 w. Glasens Annalen—Feb. 1, 1903. No. 53732 D.

Modern Machinery for Excavating and Dredging. A. W. Robinson. The first of two articles discussing the artificial methods of deepening and maintaining channels by dredging, with illustrations of modern powerful dredges and excavators. 4000 w. Engineering Magazine—March, 1903. No. 53792 B.

Plant and Methods Employed in Excavating Ambrose Channel, New York Harbor. Describes the dredges, and manner of operation, with general comments. 2500 w. Eng News—Feb. 12, 1903. No. 53542.

Embankment.

Quay Wall Construction at Rotterdam (Kadebouw te Rotterdam). R. A. Van Sandick. A very complete account of the harbor improvements at Rotterdam, with numerous illustrations showing the difficult character of the work. 10,000 w. De Ingenieur—Jan. 24, 1903. No. 53739 D.

Gauging.

See Civil Engineering, Measurement.

Isthmian Canal.

An Alternative Line for the Nicaragua Canal; and a Proposed New Method of Dam Construction. J. Francis Le Baron. A reply to the discussion of the writer's paper on this subject. 3500 w. Pro Am Soc of Civ Engrs—Jan., 1903. No. 53354 E.

The Panama Canal. George S. Morison. An illustrated article discussing the principal features of the canal, describing both plans and giving comparative estimates. 11000 w. Pro Am Soc of Civ Engrs—Jan., 1903. No. 53350 E.

The Panama Canal. John George Leigh. This first of a series of articles gives an interesting historical review of this project, with maps, sections and illustrations. 1300 w. Trac & Trans—Feb., 1903. Serial. 1st part. No. 53622 E.

Nile.

Completion of the Nile Dams. John Ward. An illustrated article describing interesting features of these recently completed reservoirs, with information in regard to the region. 2000 w. Cassier's Mag—Feb., 1903. No. 53829 B.

The Nile Reservoir. Some particulars relating to the construction of this great engineering work and the effect it will have on the country. 700 w. U S Cons Repts, No. 1568—Feb. 11, 1903. No. 53-487 D.

The Temple of Philae. An account of the examination of the foundations to make sure that the stability of the structures would not be endangered by submerging the island. Ill. 1800 w. Engng—Jan. 23, 1903. No. 53456 A.

Stream Flow.

The Stream-Flow Laboratory of the Carlsruhe Polytechnic (Le Laboratoire d'Hydraulique Fluvide de l'Institut Tecnique de Carlsruhe). A description of the testing tank for the study of the action of stream flow upon the beds and banks of rivers. 2000 w. 1 plate. Génie Civil—Jan. 24, 1903. No. 53715 D.

Teltow.

The Teltow Canal (Der Teltow Kanal). Chr. Havestadt. A description of the waterway connecting the upper Spree with the Havel. With map, profile, and sections of the channel. Serial, Part I. 1500 w. Deutsche Bauzeitung—Feb. 7, 1903. No. 53751 B.

CONSTRUCTION.

Fireproofing.

Simple Ways of Fireproofing. Russell Sturgis. An illustrated article outlining the method of building of actually fireproof buildings. 3700 w. Arch Rec—Feb., 1903. No. 53565 C.

See also Civil Engineering, Materials.

Foundations.

Experience with Foundations in Boston. Abstract of a paper by J. R. Worcester, read before the Boston Soc. of Civ. Engrs. Outlines the geologic formation and discusses principally the pile foundations and their problems. 1600 w. Eng News—Feb. 5, 1903. No. 53416.

Sub-Structure at the New Schlesinger & Mayer Store Building, Chicago. Illustrates and describes the construction of foundations under peculiar and unusual conditions. 3200 w. Eng Rec—Feb. 21, 1903. No. 53836.

Hotel Construction.

Hotel Belmont. Illustrated description of the difficult engineering features of a hotel under construction in New York City, at the corner of 42d St. and Park Ave., 26 stories high, with 5 below the surface. The conditions and requirements are in many respects unusual. The Rapid Transit Ry. passes under one corner. 5700 w. Eng Rec—Feb. 7, 1903. No. 53-502.

Masonry.

Notes on Cement Masonry. I. N. Knapp. Written for the annual meeting of the Am. Gas Lgt. Assn. Facts of interest from the writer's experience in concrete construction, with much valuable information. Also discussion. 10000 w. Stevens Ind—Jan., 1903. No. 53659 D.

Mill Construction.

Slow-Burning or Mill Construction. Edward Atkinson. Extracts from report No. V., of Insurance Engineering Experiment Station, Boston. 4000 w. Ins Engng —Jan., 1903. No. 53348 C.

Mosaic.

Methods of Mosaic Construction. W. L. H. Hamilton. An illustrated article on the revival of mosaic as an architectural adjunct, describing the old and new methods of construction. Discussion. 9300 w. Jour Soc of Arts—Feb. 6, 1903. No. 53-588 A.

Pillars.

The Construction of the Deflection Line of Straight Pillars, and their Applications in Statics (Die Konstruktion des Biegungslinie Gerader Stäbe und ihre Anwendung in der Statik). L. Vianello. A graphical treatment of flexure in struts and pillars, with practical applications. 2500 w. Zeitschr d Ver Deutschr Ing—Jan. 17, 1903. No. 53705 D.

Tunnels.

Tunnel Construction Under Water. Howard A. Carson. Abstract of informal remarks before the Boston Soc. of Civ. Engrs., with illustrations, describing the construction of the East Boston tunnel. Discussion. 6300 w. Jour Assn of Engng Socs—Dec., 1902. No. 53663 C.

MATERIALS.

Cements.

Plasters and Hard Finishing Cements in the United States. Edwin C. Eckel. Gives the divisions of the "Hydrate Cements," and some notes on Keene's cement. 900 w. Eng News—Jan. 29, 1903. No. 53312.

Progress Report of Special Committee on Uniform Tests of Cement. An important article on cement testing practice, giving the results of investigations and conclusions of a special committee appointed to determine a uniform method. Ill. 4000 w. Pro Am Soc of Civ Engrs—Jan., 1903. No. 53349 E.

The Artificial Portland Cement of Haiphong (Ciments Portland Artificiels de Haiphong). F. Schiff. A description of the cement works at Haiphong, China, and their products. 2000 w. Génie Civil —Jan. 24, 1903. No. 53714 D.

The Cement Industry and Its Prospects for 1903. Discusses the production and use, the prospect of over production, the domestic and imported products, etc. 2500 w. Munic Engng—Feb., 1903. No. 53359 C.

Concrete.

The Maximum Permissible Compression Stresses upon Concrete (Die Zulässigkeit Hoher Druckspannungen im Beton). Fritz v. Emperger. With diagrams showing the elastic limit of concrete as compared with other materials of construction. 3000 w. Beton & Eisen—1 Heft, 1903. No. 53784 F + H.

Plaster of Paris.

Tests for Plaster of Paris. Explains the composition and attending chemical and physical facts, showing a method of testing based on scientific data, and giving results of trials made by the writer. 1500 w. Stone—Feb., 1903. No. 53300 C.

Reinforced Concrete.

A Neglected Point in the Theory of Concrete Steel. John Stephen Sewell. A study of the stresses that give trouble in this material, and their causes and remedies. Ill. 1800 w. Eng News—Jan. 29, 1903. No. 53314.

Bridge in Reinforced Concrete over the Rio Caudal at Mières, Spain (Pont en Béton Armé sur le Rio Caudal à Mières, Espagne). Giving the details of computations of a reinforced concrete arch of 35 metres span by M. J. Eugenio Ribera. 3000 w. Beton & Eisen—1 Heft, 1903. No. 53782 F + H.

Comparative Tests upon Reinforced Concrete Beams (Vergleichende Proben mit Verbund Balken). L. A. Sanders. Data and results of exhaustive tests upon T beams in the direct and inverted positions; with numerous illustrations. 3000 w. Beton & Eisen—1 Heft 1903. No. 53-785 F + H.

Computing the Strength of Concrete Steel Beams. Edwin Thacher. Refers to a recent paper by Prof. W. K. Hatt and the tests reported, and gives an account of the writer's investigations with formulas. 3500 w. Eng News—Feb. 12, 1903. No. 53540.

Hennebique Fireproof Construction in New York and Cleveland. Gives particulars of this system, comparing it with the Ransome, and describing its use in buildings in the cities named. 2000 w. Eng Rec—Jan. 31, 1903. No. 53443.

Rupture Tests upon Hennebique Floors of the "Palais de Costume" (Bruchversuche mit Zwei Deckplatten System Hennebique, in "Palais de Costume.") M. Rabut. Giving details of the tests of reinforced-concrete floors made during the removal of certain buildings of the Paris exposition of 1900. 4000 w. Beton & Eisen—1 Heft, 1903. No. 53783 F + H.

The Initial Stresses in Reinforced Concrete Beams (Die Anfangsspannungen in Beton-Eisenträgern). Karl Haberkalt. An analytical examination of the manner in which imbedded rods of iron act to reinforce beams of concrete against deflection. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 30, 1903. No. 53723 B.

See also Civil Engineering, Bridges.

See also Civil Engineering, Construction.

MEASUREMENT.

Gauging.

An Electrical River Gauge. J. F. Barnes. Illustration, with description of the construction and action of an automatic recording apparatus developed by Weston M. Fulton. 1000 w. Elec Rev, N. Y.—Feb. 14, 1903. No. 53582.

Current Meter Ratings and Observations by the U. S. Irrigation Investigations Department. Describes the method employed in rating current meters and computing the results obtained, with a description also of field methods. 2300 w. Eng News—Feb. 12, 1903. No. 53541.

Road Testing.

Testing Road Surfaces by the Viagraph. Thomas Aitken. Read before the Scottish Assn. of Munic. Engrs. & Survs. Gives a report of tests carried out in London, and various cities of Scotland, showing autographic records of the irregularities of road surfaces taken by this instrument. 3800 w. Quarry—Feb. 1, 1903. No. 53-604 A.

Surveying.

The New Line of the Rhaetikon Railway (Die Neuen Linien der Rhätischen Bahn). W. Graf. A full description of the surveying work in the alignment of the tunnels on the railway between Thusis and St. Moritz, Switzerland, including the Albula tunnel. 2000 w. Schweiz Bauzeitung—Dec. 27, 1902. No. 53753 B.

Water Measurement.

See Civil Engineering, Water Supply.

Water Waste.

See Civil Engineering, Water Supply.

MUNICIPAL.

Municipal Trading.

See Industrial Economy.

Pavements.

Bituminous Macadam Pavement. C. A. Kenyon. Describes this pavement, and considers it has the good qualities of macadam, and the best qualities of asphalt pavement. 3000 w. Munic Jour & Engr—Feb., 1903. No. 53395 C.

Practice in Laying Brick Pavements. Calls attention to the care needed for the foundation, the choice of filler and its application, etc. Ill. 2200 w. Munic Jour & Engr—Feb., 1903. No. 53393 C.

Warren's Bituminous Macadam Pavement. C. A. Kenyon. Abstract of paper before the Indiana Engng Soc. Discusses the virtues and defects of macadam roads, and the improvement introduced by Frederick J. Warren. 2200 w. Munic Engng—Feb., 1903. No. 53361 C.

See also Civil Engineering, Bridges.

Refuse.

The "Fuel" Value of Town Refuse:—A Rejoinder. Frank Broadbent. A reply to an article by E. C. de Segundo, in the December issue of *Page's Magazine*. 2500 w. Elec Rev, Lond—Jan. 23, 1903. No. 53469 A.

The Fuel Value of Refuse. W. H. Booth. Discusses its value as a heat producer, and its use by electric stations. 1500 w. Elec Rev, Lond—Feb. 6, 1903. No. 53610 A.

The Sanitary Disposal of Municipal Refuse. An informal discussion of the disposal of ashes, street sweepings, dry rubbish and garbage. 13800 w. Pro Am Soc of Civ Engrs—Jan., 1903. No. 53352 E.

Septic Tank.

The Septic Tank at La Grange. Ill. William B. Ewing. Briefly describes this system of sewerage, and gives an account of the developments following the beginning of use of the tank. Ill. 1300 w. Eng Rec—Feb. 21, 1903. No. 53838.

Sewage.

The Discharge of Sewage into Dublin Harbor, Ireland. Extracts from a paper by William K. Parry and Walter E. Adeney before the Inst. of Civ. Engrs. Gives investigations made and conclusions drawn, and abstract of discussion criticizing the conclusions. 3200 w. Eng Rec—Feb. 14, 1903. No. 53638.

WATER SUPPLY.

Artesian Well.

A Peculiar Artesian Well in the Klondike. J. B. Tyrrell. Gives a brief statement of the topography and structure of the region, and explains the conditions under which the flow was encountered. Ill. 900 w. Eng & Min Jour—Jan. 31, 1903. No. 53441.

City Supply.

Concerning an Ideal Water Supply. George W. Fuller. Read before the Minnesota State San. Assn. Considers some of the aspects of public supplies and means taken to secure purity. 4800 w. Munic Jour & Engr—Feb., 1903. No. 53394 C.

Clarifying Plant.

Clarifying Plant for Waste and Drainage Waters. Translated from *Glückauf*. Illustrated description of plant in which the solid impurities are removed by mechanical means at a minimum expenditure of labor. 300 w. Col Guard—Feb. 13, 1903. No. 53693 A.

Electric Pumping.

See Electrical Engineering, Power Applications.

Fire Service.

Fire Mains. John C. Trautwine, Jr. Reviews briefly systems recently introduced in the cities of Cleveland, Milwaukee, Detroit, Buffalo, Providence, Boston, and Chicago, and describes the important features of the system introduced in Philadelphia. Ill. and tabulated results of experiments. Discussion. 14500 w. Pro Engrs' Club of Phila—Jan., 1903. No. 53671 D.

Philadelphia High-Pressure Fire Service. John E. Codman. Illustrated detailed description. Also discussion. 7500 w. Pro Engrs' Club of Phila—Jan., 1903. No. 53672 D.

Pumping Engines.

See Mechanical Engineering, Steam Engineering.

Reservoirs.

Notes on the Arrangement of Reservoirs (Erfahrungen bei Anordnung von Wasser leitungs-Reservoiren). Heinrich Adolf. A discussion of the advantages and disadvantages of various locations for reservoirs, with respect to the distribution system. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 30, 1903. No. 53724 B.

Steam Pollution.

A Sanitary Survey of Mill Creek Valley, at and near Cincinnati, Ohio. Describes the conditions of this stream which is said to be probably the foulest in the state, and the efforts under way to remedy the nuisance. 700 w. Eng News—Feb. 12, 1903. No. 53539.

Report of the Passaic Valley District Sewerage and Drainage Commissioners. Items of interest from the report of Rudolph Hering in regard to the purification of this much abused river in New Jersey. 1800 w. Eng Rec—Feb. 14, 1903. No. 53637.

Royal Commission Studies on Pollution and Self-Purification of the River Severn. Reviews the second report of the Royal Commission, giving extracts of interest. Map. 3500 w. Eng News—Feb. 19, 1903. No. 53655.

Stream Pollution and Remedial Policy. M. O. Leighton. Abstract of paper read before the Indiana Engng Soc. Considers the limitations which should obtain in all requirements made for the purpose of stopping stream pollution, and ways that a reform may be brought about. 2800 w. Munic Engng—Feb. 1903. No. 53362 C.

Waste.

Investigations of Water Waste in New York City. A statement concerning the work, how the records are made, and some of the results obtained. 2000 w. Eng News—Feb. 5, 1903. No. 53415.

The Cole-Flad Photo-Pitometer and Its Use in Studying Water Consumption and Waste. Illustrates and describes an application of the Pitot tube being used to make a water-waste survey in New York. 1500 w. Eng News—Feb. 5, 1903. No. 53413.

Water Waste Detection in New York City. An illustrated article describing the system used in these investigations. The Cole-Flad pitometer is being used. 3400 w. Eng Rec—Jan. 31, 1903. No. 53442.

Water Waste in New York City. Editorial on the investigations in progress and their important results. 1600 w. Eng Rec—Feb. 7, 1903. No. 53501.

The Standard Water Meter. Illustrated description of a new form of positive water meter being introduced in England. 700 w. Engng—Feb. 6, 1903. No. 53614 A.

Water Works.

Madeley Water Supply. An illustrated description of a plant notable as being the largest pumping plant in England operated by gas engines and producer gas. 1400 w. Engr, Lond—Feb. 6, 1903. No. 53619 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

Relays for Submarine Cables (Les Relais pour les Cables Sous-Marins). Devaux-Charbonnel. A discussion of the limitations of submarine telegraphy, and the possibility of using relays. Three articles. 3000 w. Electricien—Jan 24, 31, Feb. 7, 1903. No. 53773 each B.

The Manufacture and Laying of a Submarine Cable. Dr. A. E. Kennelly. Abstract of a lecture delivered before Sibley College. The cable described was the one made for the Mexican Government, connecting the ports of Vera Cruz, Frontera, and Campeche on the Gulf of Mexico. Description, with illustrations. 2300 w. Sib Jour of Mech Engng—Jan., 1903. No. 53662 C.

Pacific Cables.

The Cables Across the Pacific. Thomas Commerford Martin. Remarks and information regarding the British and American Pacific cables. Maps. 1500 w. Rev of Revs—Feb., 1903. No. 53356 C.

The Landing of the Honolulu End of the Pacific Cable. A brief account of the work of laying the cable, and the extent of this great work with illustrations of the ceremonies celebrating the landing at Honolulu. 1100 w. Sci Am—Jan. 31, 1903. No. 53317.

The Laying of the American Trans-Pacific Cable. Alexander G. McAdie. An illustrated account of this important project, with chart of deep-sea soundings of the coasts of California and Mexico, and between California and the Hawaiian Islands. 2500 w. Jour of Elec—Jan., 1903. No. 53626 C.

The New Pacific Cable from San Francisco to Honolulu, Hawaii. William H. Crawford, Jr. Illustrated description of the cable-ship "Silvertown," and its equipment for laying the cable and of the getting of the line ashore at San Francisco, and at Honolulu. 1500 w. Marine Engng —Feb., 1903. No. 53404 C.

Space Telegraphy.

Commercial Wireless Telegraphy. Lawrence Perry. An illustrated article describing the sending and receiving of a message by the Marconi system, with an account of the commercial success, and what has been thus far accomplished. 4200 w. World's Work—March, 1903. No. 53834 C.

Portable Station for Wireless Telegraphy (Fahrbare Stationen für Drahtlose Telegraphie). Arthur Wilke. An illustrated description of the portable Braun apparatus made by Siemens & Halske for use in the German army. 3500 w. Elektrotech Zeitschr—Jan. 15, 1903. No. 53764 B.

The Cooper Hewitt Mercury Vapor Current Interrupter. Illustrates and describes the application of the mercury vapor tube as an interrupter for use in space telegraphy. Also Dr. Michael I. Pupin's estimate of its importance. 2200 w. Elec Rev, N Y—Feb. 21, 1903. No. 53810.

The Present Position of Wireless Telegraphy. Charles Bright. Considers what has been accomplished in this field, the efficiency, difficulties, etc., and points out the great service it can render in the transmission of social, or comparatively unimportant messages, which high rates have kept from the cables. 2800 w. Nineteenth Cent—Feb., 1903. No. 53677 D.

Wireless Telegraphy. A. Frederick Collins. A review of what has been accomplished in this field, the stations established, and the present status of cableless messages. 2800 w. Rev of Revs—Feb., 1903. No. 53355 C.

Wireless Telegraphy by the Fessenden System. A. Frederick Collins. An illustrated description with report of some of the most important results achieved. 2200 w. Elec Rev, N Y—Feb. 21, 1903. No. 53811.

Telephone Cables.

Cable Construction for Telephone Lines. General specifications, with illustrations. 10,000 w. Elec Wld & Engr—Feb. 14, 1903. No. 53584.

Telephone Conduits.

Methods of Work Adopted in Constructing the Chicago Telephone Tunnels. Gives illustrated general description of the work and methods of construction of conduits for placing telephone wires underground. 2000 w. Eng News—Feb. 19, 1903. No. 53654.

Telegraphy.

Recording Telegraph for Amateurs. George M. Hopkins. An illustrated description. 1000 w. Sci Am—Feb. 21, 1903. No. 53823.

DISTRIBUTION.

Conductors.

Methods of Supporting and Protecting Inside Conductors. O. L. Falconar. Read before the Newcastle Local Sec. of the Inst. of Elec Engrs. Illustrated description of some of the methods in general use. 4500 w. Elec Engr, Lond—Jan. 30, 1903. No. 53552 A.

On Metallic Protection for Conductors. J. Prentice. Considers the metallic tube systems, as usually installed, utterly untrustworthy. 700 w. Elec Rev, Lond—Jan. 23, 1903. No. 53468 A.

Some Remarks Upon the Carrying Capacity, etc., of Copper Conductors. Gives results of experimental tests with short lengths of wire, with remarks. 1400 w. Elec Engr, Lond—Feb. 6, 1903. No. 53607 A.

Great Britain.

Electric-Power Distribution in Great Britain. Describes the work of various companies showing the use of electricity to be developing rapidly. 2500 w. U S Cons Repts, No. 1569—Feb. 12, 1903. No. 53486 D.

Mains.

The Standards for Electricity Supply Mains. Full text of the latest standard terms and conditions as agreed upon by the Cable Makers' Assn., England. 1500 w. Elect'n, Lond—Feb. 13, 1903. No. 53691 A.

Transformer Cores.

The Best Thickness for Transformer Core Plates for Minimising Iron Losses (Die Hinsichtlich der Eisenverluste Günstige Stärke von Transformatorbleche). Hans Kamps. An investigation of the thickness of sheet iron plates for transformer cores to secure a minimum loss from hysteresis and eddy currents. 1800 w. Elektrotech Zeitschr—Feb. 5, 1903. No. 53770 B.

Wiring.

The Wiring of Buildings. Review of a paper by O. L. Falconar, read before the Newcastle Section of the Inst. of Elec. Engrs. 2200 w. Elec Rev, Lond—Jan. 23, 1903. No. 53467 A.

The Use of the Multiple Pole Diagram in Graphical Wiring Computations (Der Mehrpolige Polplan in der Zeichnerischen Leitungsberechnung), G. König. Showing the application of the pole diagram and cord polygon to wiring computations in a manner similar to that used in graphostatics. 2500 w. Elektrotech Zeitschr—Jan. 29, 1903. No. 53768 B.

Three-Wire Direct-Current Wiring. P. C. Percy. Directions for wiring, determining the size of the neutral wire, etc. 1600 w. Am Electn—Feb., 1903. No. 53437.

ELECTRO-CHEMISTRY.

Electric Smelting.

Electric Steel-Smelting at Gysinge (Die Herstellung von Elektrostahl in Gysinge). F. A. Kjellin. Describing an electric furnace without carbon electrodes for smelting steel, in practical operation at Gysinge, Sweden; with data as to its performance. 1500 w. Glückauf—Jan. 24, 1903. No. 53743 B.

Electroplating.

Notes on Physical Characteristics of Electro-deposited Metals. Woolsey McA. Johnson. Discusses the influence of the chemical nature of the solution from the point of view of the electrolytic dissociation theory. 2700 w. Elec Chem Ind—Feb., 1903. No. 53645 C.

The Abuse of Electroplating. H. L. Haas. Briefly notes old methods and the important advances made, with remarks on knowledge still needed. 1100 w. Elec Chem Ind—Feb., 1903. No. 53642 C.

The Alloying of Metals as a Factor in Electroplating. Prof. Louis Kahlenberg. Shows that the alloying power of the electrolytic deposit with the coated metal underneath is a factor determining not only the strength with which the deposit adheres, but the length of time the plated article will wear. 1500 w. Elec Chem Ind—Feb., 1903. No. 53641 C.

The Physical Character of Metal Deposits. Prof. C. F. Burgess and Carl Hambuechen. An illustrated article giving information of value and interest in regard to the deposition of metals. 2500 w. Elec Chem Ind—Feb., 1903. No. 53643 C.

Nickel Refining.

History and Present Development of Electrolytic Nickel Refining. Titus Ulke. Describes the Vivian, Balbach, Cleveland, Hamilton, and Papenburg electrolytic nickel works, and discusses the proposed copper and nickel refinery at Sault Ste. Marie. Ill. 4000 w. Elec Chem Ind—Feb., 1903. No. 53644 C.

Storage Battery.

Ampere-Hour Capacity of the Lead Storage Battery. A. L. Marsh. Deals particularly with lead peroxide, showing the present limitations of the lead storage cell in regard to weight and output. 1500 w. Elec Wld & Engr—Feb. 14, 1903. No. 53586.

Structural Details of the Edison Storage Battery. Illustration and cross-section with brief description. 600 w. Sci Am—Feb. 7, 1903. No. 53480.

The Accumulator as a Problem in Electrochemistry (L'Accumulateur et l'Electrochemie). J. Izart. A consideration of the electrochemical principles on which the action of the accumulator is based with examples of computations. Two articles. 2000 w. Electricien, Jan. 24, Feb. 7, 1903. No. 53774 each B.

ELECTRO-PHYSICS.

Graphics.

The Graphical Treatment of Alternating Current Phenomena (Ueber die Graphische Behandlung von Wechselstromproblemen). Dr. E. Orlich. An elementary demonstration of the application of the vector analysis to the study of alternating currents. 1800 w. Elektrotech Zeitschr—Jan. 22, 1903. No. 53767 B.

Interrupter.

See Electrical Engineering. Communication.

Ionization.

The Ionization of Water Nuclei. C. Barus. An account of experimental investigations on the Lenard effect, referring to the work of J. J. Thompson, and giving the result of the writer's study. Ill. 4200 w. Am Jour of Sci—Feb., 1903. No. 53368 D.

Oscillations.

Apparatus for Experiments upon Rapid Electric Oscillations (Vorführung von Experimenten über Schnelle Elektrische Schwingungen). Dr. Georg Seibt. A lecture before the Elecktrotechnische Verein with experiments upon the wireless transmission and reception of electric waves. 3000 w. Elektrotech Zeitschr—Feb. 5, 1903. No. 53771 B.

Plants.

Electromotive Force in Plants. Amon B. Plowman. Reviews the work in this field by Prof. J. Burden Sanderson, giving his conclusions, and offers hints explanatory of the phenomena on which his conclusions are based. 3000 w. Am Jour of Sci—Feb., 1903. No. 53367 D.

Radioactivity.

Concerning Induced Radioactivity and the Emanations from Radium (Sur la Radioactivite Induite et sur l'Emanation du Radium). P. Curie. A communication to the French Academy, discussing the theories of Rutherford. 1500 w. Comptes Rendus—Jan. 26, 1903. No. 53735 D.

The Magnetic Deviability of Certain Rays Emitted by Radium and Polonium (Sur la Déviabilité et la Nature de Certains Rayons Emis pas le Radium et le Polonium). H. Becquerel. A discussion of experiments confirming those of Rutherford as to the influence of a magnetic field upon Becquerel rays. 1500 w. Comptes Rendus—Jan. 26, 1903. No. 53734 D.

Thermo-Electricity.

Observations on Thermo-Electric Currents (Beobachtungen über Thermoelektrische Ströme). Albrecht Heil. An account of experiments with thermo-elements of various metals, with a discussion of possible improvements. 2500 w. Zeitschr f Elektrochemie—Jan. 29, 1903. No. 53776 D.

Transformer Cores.

See Electrical Engineering. Distribution.

GENERATING STATIONS.

Alternators.

The Calculation of the Electromotive Force of Alternators (Le Calcul de la Force Electromotrice dans les Alternateurs). C. F. Guilbert. A mathematical discussion of the influence of the form of construction upon the electromotive force of alternating generators. 2000 w. Revue Technique—Jan. 25, 1903. No. 53722 D.

Boosters.

The Use of Negative Boosters. Explains the action of these boosters, employed to prevent the potential difference exceeding the allowable maximum. Ill. 1900 w. Tram & Ry Wld—Jan. 15, 1903. No. 53326 B.

Carbon Brushes.

Experiments on the Resistance of Carbon Brushes (Ersais sur la Resistance au Contact des Balais en Charbon). M. Bourguignon. Data and results of exhaustive tests of the contact resistance of carbon brushes for dynamos, with discussion by the Societé. 5000 w. Bull Soc Int d Electriciéns—Jan., 1903. No. 53786 H.

Equalizers.

Equalizers for Direct Current Dynamos. Alphonse A. Adler. Describes the methods found most satisfactory for transferring loads from one machine to another. 2300 w. Elec Age—Feb., 1903. No. 53375.

Erection.

The Erection of Large Generators. Louis Elliott. General notes on the setting and assembling of heavy units. 2200 w. Steam Engng—Feb. 10, 1903. Serial, 1st part. No. 53527.

Heating.

The Influence of Surface and Speed upon the Heating of Dynamos (Ueber den Einfluss der Beschaffenheit der Oberfläche von Elektrischen Maschinen und der Tourenzahl auf die Erwärmung). Dr. Wilhelm Schüppel. Experiments with surfaces of various colors upon the radiation of heat from dynamos; also the relation of speed to heating. 3000 w. Elektrotech Zeitschr—Feb. 8, 1903. No. 53780 D.

Hydro-Electric.

The Extension of the Schaffhausen Electric Works (Die Erweiterungs bauten der Elektrizitäts werke in Schaffhausen). Illustrated description of recent additions to the plant, and an account of the electric tramway system of the city. 1800 w. Schweiz Bauzeitung—Dec. 27, 1902. No. 53752 B.

The Hydro-Electric Station of the Jonage Canal (Usine Hydro-Electrique du

Canal de Jonage). H. Clement. A description of the station by which 14,666 horse power is derived, from the power of the Rhone and delivered electrically to Lyons. 2500 w. 1 plate. Revue Industrielle—Feb. 7, 1903. No. 53799 D.

The New Mill Creek Power Plant of the Edison Electric Co., near Redlands, Cal. E. Duryee. Illustrated detailed description. 1600 w. Eng News—Feb. 5, 1903. No. 53414.

Isolated Plant.

Power Plant of the Ferguson-McKinney Dry Goods Co., St. Louis. William H. Bryan. Illustrates and describes a plant representing present practice, and showing the severe conditions of plants for furnishing light, heat, power, etc., for large buildings. 6000 w. Engr, U S A—Feb. 2, 1903. No. 53418.

Municipal Plant.

Municipal Electric Light and Power Plant at Richmond, Ind. James B. Nelson. Abstract of a paper read at the annual meeting of the Indiana Engng. Soc. Descriptive. 2000 w. Eng News—Jan. 29, 1903. No. 53310.

Niagara.

Remarkable Emergency Work at Fire of the Niagara Falls Power Plant. An illustrated account of the accident due to the plant being struck by lightning, and the rapidity with which the lines were placed in service afterward. 1000 w. Elec, N Y—Feb. 11, 1903. No. 53524.

Railway Station.

Power Plant of the Aurora, Elgin & Chicago Railway. Illustrates and describes a plant for furnishing power for a road 56 miles in length, which has been constructed and equipped for speeds equal, if not greater, than steam roads. 3000 w. Eng Rec—Feb. 7, 1903. No. 53504.

Regulators.

Automatic Voltage Regulators. H. C. Wirt. Abstract of a paper read before the Northwestern Elec. Soc. Remarks on the importance of constant pressure, with description of a regulator invented by A. A. Tyrrell. Ill. 2000 w. Elec Rev, N Y—Feb. 14, 1903. No. 53583.

Shipyard.

The Light and Power Plant of the Vulcan Works at Stettin (Die Versorgung der Werkstätten der Stettiner Maschinenbau—A. G. Vulcan mit Kraft und Licht). A. Böttcher. A general description of the power plant of the great Vulcan shipyards, and of the electrical equipment. Serial. Part I. 2500 w. Zeitschr d Ver Deutscher Ing—Jan. 24, 1903. No. 53706 D.

Sunderland.

The Sunderland Corporation Electricity Works. Gives illustrations and descriptions of some of the equipment, with an account of this municipal enterprise and its growth. 4500 w. Trac & Trans—Feb., 1903. No. 53623 E.

See also Street and Electric Railways.

LIGHTING.

Car Lighting.

See Railway Engineering, Motive Power and Equipment.

Incandescent Lamps.

Methods of reducing the Cost of Lighting with Incandescent Lamps (Methoden zur Herabminderung der Kosten der Beleuchtung mittel Elektrischer Glühlampen). Karl Zipernowsky. With curves, showing the life of lamps under various conditions, and their periods of greatest efficiency. 3000 w. Zeitschr f Elektrotechnik—Feb. 1, 1903. No. 53779 D.

Intermittent Currents.

Suggestions for the Use of Intermittent Currents for Electric Lighting. S. H. Holden. Points out means whereby currents which are constant as to direction but periodic as to intensity may be satisfactorily generated, and some uses to which they may be put. 1700 w. Elec Rev, Lond—Jan. 23, 1903. No. 53470 A.

Mercury Arc.

The Mercury Arc. Charles P. Steinmetz. An account of the writer's investigations discussing the features of the mercury arc, and giving a review of the work of others. Also editorial. 2500 w. Elec Wld & Engr—Feb. 21, 1903. No. 53817.

Rates.

Rates and Methods of Charging. J. W. Shuster. Read at meeting of the Northwestern Elec. Assn. Outlines methods of changing for electric current in use in the United States. 2500 w. Am Gas Lgt Jour—Feb. 9, 1903. No. 53491.

Ship Installations.

Ship Lighting. Frank Broadbent. Explains the unfortunate circumstances that affect the wiring of ships, and discusses the generating plants, governors, steam and exhaust service, dynamos, switchboards and fuseboards, in the present article. 2400 w. Elec Rev, Lond—Feb. 6, 1903. Serial, 1st part. No. 53608 A.

MEASUREMENT.

Bearings.

The Electrical Resistance of Bearings. A. E. Kennelly and C. A. Adams. Gives results of experimental study of this subject. 800 w. Elec Wld & Engr—Feb. 7, 1903. No. 53488.

Galvanometer.

An Electrolytic Galvanometer (Elektrolytisches Galvanometer). Richard Heilbrun. The circulation of the current in a tube containing the electrolyte acts upon the suspended magnet of a mirror galvanometer. 1800 w. Zeitschr f Elektrochemie—Feb. 5, 1903. No. 53777 D.

Construction of a D'Arsonval Mirror Galvanometer. F. W. Cerny. Illustrated description of a self-adjusting instrument built by the writer. 700 w. Am Electn—Feb., 1903. No. 53435.

Instruments.

Electrical Measuring Instruments. Caryl D. Haskins. Considers instruments used in daily practice for purposes of frequent observation and indication of conditions. Ill. 5400 w. Jour Fr Inst—Feb., 1903. No. 53571 D.

Photometry.

Dr. Fleming's Paper on Photometry. Alexander P. Trotter. A critical review. 2800 w. Elec Times—Feb. 5, 1903. No. 53597 A.

Testing.

The Economic Value of Testing. Prof. George D. Shepardson. Abstract of paper read before the Northwestern Elec. Assn. Urges the buying of accurate instruments and having men competent to use them, in central stations for the manufacture and sale of electrical energy. 4000 w. Elec Wld & Engr—Feb. 9, 1903. No. 53489.

POWER APPLICATIONS.

Air Gap.

An Experimental Study of the Influence of Various Air Gaps in Polyphase Motors (Eine Experimental studie über den Einfluss Verschiedener Grossen des Luftzwischenraumes bei Drehstrommotoren). Dr. Max Breslauer. With diagrams showing the influence of changes in the width of the air gap upon the action of motors. 2000 w. Zeitschr f Elektrotechnik—Jan. 18, 1903. No. 53778 D.

Capstans.

Electric Capstans and Cranes at North Eastern Co.'s Railway Docks. Frank C. Perkins. Illustrates and describes some of the details of the installation at these English docks. 2400 w. Mod Mach—Feb., 1903. No. 53411.

Cotton Mill.

Electric Driving at the Mirecourt Cotton Mills (Commande Electrique des Usines de la Société Cotonnière de Mirecourt). J. A. Montpellier. General description of this important installation, in which 650 h. p. is distributed electrically with an efficiency of 71 per cent. 2000 w. Electricien—Jan. 17, 1903. No. 53772 B.

Department Store.

The Electrical Equipment of the New Macy Store Building. Charles E. Knox. Illustrated description of a recently installed plant, which furnishes electricity for lighting, and for driving motors for parcel conveyors, pneumatic blowers, carpet and sewing machines, ventilating fans, glass-cutting machines, etc. 3000 w. Am Electn—Feb., 1903. No. 53433.

Factory Plant.

Electric Power Transmission at Arbroath. An illustrated account of the plant installed at the Lowson Mills, which operates six factories situated in different parts of the same town. 3000 w. Engng—Feb. 13, 1903. No. 53696 A.

Hoisting.

Improvements in the Application of Electricity to Mine Hoisting Machinery (Neuerungen in der Verwendung der Elektrizität beim Fördermaschinenbetriebe). R. Schmidt. Describing the electric winding plant in operation at the Germania Mine near Marten, in the Dortmund district; the shaft is 450 metres deep. 3500 w. Glückauf—Jan. 31, 1903. No. 53744 B.

Winding Machines with Direct-Connected Motors (Die Fördermaschinensysteme mit Direkt Gekuppelten Motoren). H. Baum. A discussion of the application of electric driving to heavy mine hoisting. Serial, part I. 3000 w. Glückauf—Feb. 7, 1903. No. 53746 B.

Induction Motors.

The Care of Induction Motors in a Large Factory. Arthur B. Weeks. Hints for the inspection and care of these motors. 1200 w. Am Electn—Feb., 1903 No. 53438.

Iron Works.

Alternating vs. Direct-Current, as Applied to the Iron and Steel Industry. C. H. Hines. Arguments as to the respective merits of the two systems, with the conclusion that the alternating current will be the equal of the direct in all cases, and its superior in most of them. 1200 w. Elec Wld & Engr—Feb. 21, 1903. No. 53816.

Electrical Power at Sir B. Samuelson and Company's Iron Works, Middlesbrough. Ernest D. Phillips. Illustrated detailed description of the plant and its applications. 4200 w. Ir & Coal Trds Rev —Jan. 30, 1903. No. 53564 A.

Machine Driving.

Power Required to Drive Machine Tools. An account of tests made in the locomotive shops of the Buffalo, Rochester & Pittsburg Ry. at Du Bois, Pa., to ascertain the amount of power used in regular routine work, and also the power lost in shafting and belting. Describes shops. 3500 w. Ir Age—Feb. 12, 1903. No 53525.

Manchester, N. H.

Electric Water Power at Manchester, N. H. Mills. Illustrated article giving interesting facts in regard to this industrial plant operated with power from distant waterfalls. 1700 w. Elec Wld & Engr—Feb. 14, 1903. No. 53585.

Motors.

Recent Forms of Non-Synchronous Motors with Compensation and Compounding (Asynchron-Maschinen mit Kompensierung und Compoundierung in ihrer Heutigen Ausführung). Alexander Heyland. Describing the improved windings adopted for the latest types of Heyland motor. Three articles. 10,000 w. Elektrotech Zeitschr—Jan. 22, 29, Feb. 5, 1903. No. 53765 each B.

Pumping.

Electric Pumping Plant at the Bridgeport Station, Chicago, for the Illinois & Michigan Canal. Outlines the history of this station established for the purpose of supplying water in time of drought, giving illustrated description of the present plant. 800 w. Eng News—Feb. 19, 1903. No. 53656.

Electric Pumping Plant at Kaiserstuhl II Shaft, Dortmund, Germany. Frank C. Perkins. An illustrated description of the steam plant and electric machinery. 2500 w. Mines & Min—Feb., 1903. No. 53523 C.

Rollers.

Electrical Driven Road Rollers (Rouleaux-Compresseurs à Traction Electrique). A. Dumas. A description of the electrically operated compressing rollers, used for solidifying the earthen dikes of Grosboï's and Saint-Fargean. 1800 w. 1 plate. Génie Civil—Feb. 7, 1903. No. 53719 D.

Rolling Mill.

Electrically Driven Rolling Mill (Eine Elektrisch Betriebene Feinstrasse). F. Janssen. Illustrated description of the new electric equipment of the Bergischen Steel Works at Remscheid, constructed by the Union Elektrizstäts Gesellschaft of Berlin. 2500 w. Stahl u Eisen—Jan. 15, 1903. No. 53758 D.

Shunt-Motor.

Action of a Shunt-Wound Motor when Driven by a Series-Wound Dynamo. A. S. M'Allister. A study of the operation. Ill. 1100 w. Am Electn—Feb., 1903. No. 53434.

Speed Control.

Communications and Discussions. Additions to the discussion of previous papers on variable speed control. 7000 w. Trans Am Inst of Elec Engrs—Jan., 1903. No. 53670 D.

Some Variable Speed Motor Drives. Thomas J. Fay. A discussion of the electrical application of motors to machine tools, with illustrations, methods, and results. 2300 w. Elec Rev, N Y—Feb. 21, 1903. No. 53813.

TRANSMISSION.

Alternators.

Alternators for Electrical Transmission. Alton D. Adams. Considerations as to the number of dynamos in the generating station of a transmission system, describing the three types of alternators used, the voltages, etc. 3700 w. Elec Rev, N Y—Feb. 21, 1903. No. 53812.

Cables.

The Capacity of Cables (Die Kapacität von Kabeln). Dr. Hubert Kath. A discussion of the influence of resonance and Tesla effects upon the capacity of long cables for power transmission. 2000 w. Elektrotech Zeitschr—Jan. 15, 1903. No. 53763 B.

The Sheathing and Protection of Cables (Ueber Kabel Schutzhüllen und Abdeckung deren Verwendung und Verlegung). J. Schmidt. A general and exhaustive discussion of the protection of underground electric cables and the conduits in which they are laid. Serial. Part I. 4000 w. Elektrotech Zeitschr—Jan. 22, 1903. No. 53766 B.

California.

The Generating Transmission and Distribution Systems of the Edison Electric Company of Los Angeles, Cal. George P. Low. An illustrated detailed description of the principal hydraulic, mechanical, and electrical features. 24,800 w. Jour of Elec—Jan., 1903. No. 53627 C.

The Systems of the United Electric, Gas and Power Company. Illustrates and describes the systems at Santa Barbara and Santa Monica. 4500 w. Jour of Elec—Jan., 1903. No. 53629 C.

The Water and Electric Systems of the South Yuba. Rudolph Warner Van Norden. An interesting illustrated detailed description of these systems, with map and engineering data. 13600 w. Jour of Elec—Jan., 1903. No. 53628 C.

Costs.

Costs and Losses of Electric Transmission Lines. Alton D. Adams. Gives a comparison of figures shown in operating a number or representative plants. 2500 w. Mines & Min—Feb., 1903. No. 53520 C.

High-Voltage.

A High-Voltage Power Transmission. M. H. Gerry, Jr. An illustrated description of the various details of the reconstructed plant of the Missouri River Power

Co. 6600 w. Pro Am Soc of Civ Engrs—Jan., 1903. No. 53351 E.

26,000-Volt Installation at Grenoble, France. C. L. de Muralt. Illustrated description of the plant of the Société Hydro-Electrique de Fure et Morge, which supplies electricity for power purposes to a number of factories. 4000 w. Elec Wld & Engr—Jan. 31, 1903. No. 53432.

Lightning Arrester.

Lightning Arrester for High Tension Currents (Parafoudre pour Haute Tension). A. Bainville. An illustrated description of the Schoen & Felix arrester, made up of elements which can be assembled in any desired number. 1000 w. Electricien—Jan. 31, 1903. No. 53775 B.

Long Distance.

The Power Transmission from St. Maurice to Lausanne (Die Kraftübertragung von St. Maurice nach Lausanne). A description of the hydro-electric station of St. Maurice on the Rhone, Switzerland, and the transmission of 5000 h. p. to Lausanne, 56 kilometres distant. 3000 w. Zeitschr d Ver Deutscher Ing—Jan. 17, 1903. No. 53703 D.

Overhead Wires.

The Computation of Sag of Wires (Berechnung des Drahtdurchhanges). K. Otto. Deducing formulas for the sag of overhead wires for various conditions of tension, temperature, and wind. 2000 w. Elektrotech Zeitschr—Jan. 15, 1903. No. 53762 B.

Polyphase.

Polyphase Work in 1903. A. C. Eborale. Reviews the present position of heavy electrical engineering, indicating some of the lines upon which the work is progressing, and the future outlook. 2200 w. Elec Rev, Lond—Feb. 6, 1903. Serial, 1st part. No. 53609 A.

MISCELLANY.

Address.

Mr. H. A. Earle's Inaugural Address to the Manchester Section of the Institution of Electrical Engineers. Abstract. Brief review of progress during the past 20 years, and subjects connected with electric lighting. 3500 w. Elect'n, Lond—Jan. 30, 1903. No. 53535 A.

Design.

Electrical Design. Reviews papers by Mr. Esson and Mr. E. K. Scott, dealing with the design of electrical machinery. 1000 w. Elec Rev, Lond—Jan. 23, 1903. No. 53471 A.

Education.

The Engineers Who Will Be Wanted. Alfred H. Mayes. Considers the method of training that will best prepare students for electrical engineers. 1900 w. Elec Engr, Lond—Jan. 23, 1903. No. 53474 A.

Fire Hazards.

Some Electrical Fire Hazards. Washington Devereux. An examination of some of the causes that may create a fire from electricity. Also discussion. 6000 w. Pro Engrs' Club of Phila—Jan., 1903. No. 53673 D.

GAS WORKS ENGINEERING

Car Lighting.

See Railway Engineering, Motive Power and Equipment.

Cyanogen.

Cyanogen Recovery. Abstracts of papers by Herr Ritzinger, Dr. Nauss, and Dr. Bueb on the recovery of cyanogen. 4000 w. Gas Wld. Feb. 14, 1903. No. 53680 A.

Fans.

Fans in Gas Works. R. Gordon Mackay. The present article deals with the theory of centrifugal fans, more particularly specialized to the needs of gas engineers. 2500 w. Jour Gas Lgt—Jan. 27, 1903. No. 53479 A.

Gas Engines.

See Mechanical Engineering, Special Motors.

Gas Power.

See Mechanical Engineering, Power and Transmission.

German Practice.

The Progress of the Recovery Coke-Oven in Germany. Digest of a recent article in the *Zeitschrift für Beleuchtungswesen* supplementing the paper of Herr Hilgenstock on "German Coke-Oven Practice" and showing the present trend of affairs in Germany in regard to the manufacture and importation of tar and ammonia. 1100 w. Jour Gas Lgt—Feb. 10, 1903. No. 53684 A.

High-Pressure.

Engineering Works and Shop Lighting by the High-Pressure Gas System. Gives night photographs of the lighting by this system with account of its success. 1700 w. Jour Gas Lgt—Feb. 10, 1903. No. 53682 A.

Illuminants.

Fire Risks of Illuminants. E. Frank Williamson. The present article discusses oil lamps and gas. 1600 w. Aust Min

Stand—Jan. 1, 1903. Serial, 1st part. No. 53600 B.

India.

The Lighting of Some Indian Cities. A. J. Kennedy. Gives brief accounts of Madras and Jeypore. 1800 w. Gas Wld —Jan. 24, 1903. No. 53477 A.

Invention.

The Trend of Gas Invention. Reviews the patents in the gas field for the last year, comparing it with the year previous. 2700 w. Jour Gas Lgt—Jan. 27, 1903. No. 53478 A.

Leakage.

Gas Leakage and the Public Health. James C. Bayles. Read before the Med. Soc. of the Co. of N. Y. Considers the amount of leakage; what becomes of the gas; the risks of fires and explosions, asphyxiation, blood poisoning and anaemia. etc. 3500 w. Dom Engng—Jan. 25, 1903. No. 53380 C.

Oil Gas.

An Oil-Gas System for Isolated Plants. Shows the worthlessness of some advertised fuel processes, and describes the fuel gas system of the Acme Gas Co. 2200 w. Eng News—Jan. 29, 1903. No. 53313.

"Petrogene."

"Petrogene" Air Gas to Replace Dear Coal Gas. An account of a system being exploited in England, giving plans of plant, and a comparative statement of cost. 3400 w. Jour Gas Lgt—Feb. 3, 1903. No. 53606 A.

Photometry.

See Electrical Engineering, Measurement.

Piping.

Notes on House Piping. Discusses the table proposed by the Research Committee comparing it with other tables. 2000 w. Am Gas Lgt Jour—Feb. 2, 1903. No. 53389.

Prussian Blue.

The Determination of Prussian Blue in Spent Oxide. Abstract translation of a paper by Dr. Luhrig who had made an exhaustive study of this question. 1000 w. Jour Gas Lgt—Feb. 10, 1903. No. 53685 A.

United Kingdom.

Gas Undertakings Returns. Information from the recently issued returns for the United Kingdom. 1500 w. Jour Gas Lgt—Jan. 20, 1903. No. 53327 A.

Water Gas.

Blue Water Gas at Ilford, and Elsewhere. A. G. Glasgow. A statement in defense of the Lowe process. 3700 w. Jour Gas Lgt—Feb. 10, 1903. No. 53683 A.

Some Experiences with Water Gas. Harold E. Copp. Some of the writer's experiences with report of tests made. 1200 w. Jour Gas Lgt—Jan. 20, 1903. No. 53328 A.

INDUSTRIAL ECONOMY

Coal Tariff.

The Question of Free Coal. W. Blakemore. An examination of the advantages and disadvantages of a reciprocal free coal agreement between the United States and Canada. 3000 w. Can Min Rev—Jan. 31, 1903. No. 53386 B.

Cost Keeping.

Cost Finding Methods for Moderate-Sized Shops. William Magrutor. A description of the system of the Southern Engine and Boiler Works, employing about 300 men on engines, boilers, and saw-mill machinery. 2500 w. Engineering Magazine—March, 1903. No. 53794 B.

Cost Keeping in Foundries. Edward Kirk. Arguing that nothing of value is gained, and the labor really adds to the cost of castings. 2800 w. Foundry—Feb., 1903. No. 53364.

Education.

Science Workshops for Schools and Colleges. Prof. Henry E. Armstrong. Arguments for training in scientific method, illustrated by reference to the new buildings at Horsham for Christs' Hospital School, and their equipment. Illustrations and discussion. 12500 w. Jour Roy Inst of Brit Archts—Jan. 24, 1903. No. 53678 F.

Exposition.

The International Exposition at St. Louis, 1904 (Die Weltausstellung in St. Louis, 1904). Paul Moller. A general account of the status of the buildings and preparations at the beginning of 1903, as seen by a visiting German engineer. 3000 w. Zeitschr d Ver Deutscher Ing—Jan. 10, 1903. No. 53700 D.

Labor.

The Bloomington Law and Order League. Editorial commending the declaration of this organization and the work it has undertaken to protect all who wish to earn a living. 2000 w. Ir Age—Feb. 12, 1903. No. 53526.

Labor Commission.

The Recent British Trades Unions Visit to the United States. Alfred Mosely. Gives details of things seen by the Mosely

Commission, the reasons for the visit, and the results looked for. 4000 w. Cassier's Mag—Feb., 1903. No. 53831 B.

Municipal Trading.

The Cost of Municipal Trading. Dixon H. Davies. A detailed discussion of the advantages and disadvantages claimed, with suggestions, also discussion. 15600 w. Jour Soc of Arts—Jan. 30, 1903. No. 53549 A.

Premium System.

The Premium Plan from the Workman's Standpoint. F. A. Halsey. Extracts from an address before the Civic Federation. Gives opinions from various points where the system has been tried all favorable to its working. 2000 w. Am Mach—Feb. 5, 1903. No. 53450.

The Premium System of Wages (Das Prämiensystem der Arbeiterlöhnung). F. Preuss. A general discussion of the premium system with diagrams comparing day's work and piece work with the systems of Halsey and of Rowan. 2500 w. Zeitschr d Ver Deutscher Ing—Jan. 31, 1903. No. 53709 D.

Profit-Sharing.

Profit-Sharing in America. Editorial discussion of the scheme of the United States Steel Corporation. 3200 w. Engng Jan. 23, 1903. No. 53454 A.

Shipping.

Transatlantic Shipping Business. A discussion regarding the affect of the Morgan combine and Cunard agreement with the British Government, with criticisms of the Cunard agreement. 5000 w. Marine Rev—Feb. 19, 1903. No. 53805.

Trade-Unions.

A Workingman's View of Trade-Unions. James G. Hutchinson. Discusses these associations in England, and suggests improvements in trade-union tactics. 4000 w. Nineteenth Cent—Feb., 1903. No. 53676 D.

Free Shops for Free Workingmen. W. H. Pfahler. Read before the Am. Econ. Assn. Outlines the existing conditions and considers the reasons why employers oppose the "union shop." 2000 w. Ir Trd Rev—Jan. 29, 1903. No. 53383.

Labor Unions and the Law. A. Maurice Low. Discussing the recent Taff Vale decision in England, making unions liable for damages. 1600 w. Rev of Revs—Feb., 1903. No. 53358 C.

Trade Unions and the Law of Conspiracy. A discussion of the proposed bill to be brought before the British parliament. 1400 w. Engng—Feb. 6, 1903. No. 53616 A.

Trusts.

Anti-Trust Bills in Senate and House. Reviews bills so far as they relate to railways. 3400 w. Ry Age—Jan. 30, 1903. No. 53382.

MARINE AND NAVAL ENGINEERING

Auxiliary Motor.

Explosion Motors on Sailing Boats (Les Moteurs à Explosion â Bord des Bateaux de Péche à Voiles). G. Soé. A description of the manner in which auxiliary gasoline motors have been successfully used on French fishing boats. 2000 w. Le Yacht—Feb. 7, 1903. No. 53798 D.

Battleships.

The Chilian Battleship Constitution. Illustration with detailed descriptions of this new vessel, with a comparative table. 1700 w. Engr, Lond—Jan. 23, 1903. No. 53462 A.

Bilge Keels.

The Influence of Bilge Keels on the Resistance and the Rolling of Vessels in Still Water. Johann Schuette. Translated from a paper read before the Schiffbautechnische Gesellschaft, Berlin. An account of experimental investigations with a model, and the interesting results. 1300 w. Marine Engng—Feb., 1903. No. 53408 C.

Boilers.

See Mechanical Engng., Steam Engng.

British Navy.

Science and the Navy. Discusses favorably the new scheme of entry, education and training of officers. 3500 w. Nature—Jan. 29, 1903. No. 53548 A.

The British Naval Engineer Under the New Scheme. Charles M. Johnson. A review of the recent memorandum of the First Lord of the Admiralty regarding the new arrangements of the personnel. 4000 w. Engineering Magazine—March, 1903. No. 53797 B.

Construction.

Approximate Formulas in Ship Construction (Annäherungs-Formeln im Schiffbau. M. H. Bauer. An examination of the working formulas used in ship construction, showing the limits within which approximations may be safely used. Serial, Part I. 2000 w. Schiffbau—Jan. 23, 1903. No. 53787 D.

Cruiser.

The Russian First Class Cruiser "Bogatyr." Illustrated detailed description of vessel designed to meet conditions required by the Russian Government, and of the armament, its protection, etc. 4200 w. Engng—Feb. 13, 1903. Serial, 1st part. No. 53694 A.

Ice Breaker.

A Vessel for North Polar Navigation and Discovery. Charles Baillairge. Gives cross-section and brief description of a proposed construction. 1200 w. Can Engr —Feb., 1903. No. 53481.

London.

The Port of London, Benedict W. Ginsburg. Gives a résumé of the position and prospects of this seaport; considering improvements needed for the handling of supplies, dock management, the river, etc. Discussion. 10,000 w. Jour Soc of Arts —Feb. 13, 1903. No. 53679 A.

Motor Boats.

The Construction of Motor Launches. W. F. Durand. Considers the purpose the builders must keep in view and gives hints regarding the construction. Ill. 3800 w. Marine Engng—Feb., 1903. No. 53409 C.

Naval Artillery.

The Tactical Employment of Naval Artillery. Discusses the principles of naval gunnery and the relative bearing and importance of the various artillery questions in the navy. 15,000 w. Trac & Trans—Feb., 1903. No. 53621 E.

Pipe Plan.

Marine Engineering Design—The Pipe Arrangement. J. Calder. Diagram of water and steam connections for the triple-expansion engine and auxiliary machinery of a modern freight steamer of 1,500 I. H. P. and 10 knots speed is given, with explanatory notes. 1200 w. Marine Engng—Feb., 1903. No. 53407 C.

Propeller Shafts.

See Mechanical Engineering, Power and Transmission.

Shipping.

See Industrial Economy.

Steamships.

Notable New American Steamships. Illustrates and describes the Siberia and Korea, two fine vessels intended for service on the Pacific, between San Francisco, Hawaii, Japan and China. 1400 w. Naut Gaz—Feb. 5, 1903. No. 53484.

Tender.

New Light House Tender. Full description and plans of the Magnolia, building for gulf service. 2000 w. Naut Gaz—Feb. 19, 1903. Serial, 1st part. No. 53808.

Vibration.

The Vibrations of Steamships. G. W. Melville. An exhaustive study of the methods of balancing marine engines, reviewing the Yarrow-Schlick-Tweedy system, and showing its inability to provide for the second and higher periods. An important paper by the Engineer-in-Chief of the U. S. Navy. Serial, Part I. 2000 w. Engng—Jan. 2, 1903. No. 53444 A.

Warnings.

Aids to Navigation. Col. William P. Anderson. From an address in Ottawa. Reviews the development of lighthouses, buoys, lightships, etc., on the Canadian shores. 4500 w. Marine Rev—Jan. 29, 1903. No. 53381.

MECHANICAL ENGINEERING

AUTOMOBILES.

Brakes.

Some Notes on Brakes. J. V. S. Bickford. Remarks the tendency to standardization, describes the plans of equalizing the strain of the brake wires, the double-acting brake, etc. 1100 w. Horeless Age —Feb. 11, 1903. No. 53515.

Cooling.

Defective Water Circulation. C. Will Travis. Points out the causes of some of the deficiencies in cooling systems for gasoline engines and suggests an improvement. 1600 w. Horseless Age—Feb. 4. 1903. No. 53483.

Exhibitions.

A Critical Review of the Show. Albert L. Clough. A review of the recent exhibition at Madison Sq. Garden. 3000 w. Horseless Age—Jan. 28, 1903. No. 53319.

Second Annual Automobile Show in Chicago. An illustrated account, with brief descriptions of new cars exhibited and features of interest. 9400 w. Automobile—Feb. 21, 1903. No. 53809.

The American Automobile. Hugh Dolnar. A brief review of the recent exhibition at Madison Sq. Garden, and what it means to the machine trade. 1200 w. Am Mach—Jan. 29, 1903. No. 53307.

The Crystal Palace Automobile Show. Illustrated descriptions of the steam, patrol, and electric cars exhibited. 10,000 w. Motor Car Jour—Feb. 7, 1903. No. 53595 A.

The Crystal Palace Motor Car Show. Editorial review of this London exhibition. 3200 w. Engng—Feb. 6, 1903. No. 53615 A.

The Paris Exhibition of Automobiles. Begins an illustrated description of several of the interesting machines exhibited, 2300 w. Engng—Jan. 23, 1903. Serial, 1st part. No. 53452 A.

The Show and Its Lessons. Harry B. Haines. Notes improvements, types, sales, etc. 1900 w. Horseless Age—Jan. 28, 1903. No. 53320.

The Stanley Automobile Exhibition. Illustrations and notes concerning the cars exhibited, tires, etc. 3200 w. Auto Jour—Jan. 24, 1903. No. 53476 A.

Gasoline Vehicles.

The Development of the Commercial Gasoline Automobile. Albert L. Clough. Discusses the fuel question, the tire problem, traction in snow, and intelligent operators. 2000 w. Horseless Age—Feb. 4, 1903. No. 53482.

Ignition.

Electric Ignition Generators. Herbert L. Towle. Points involved in their construction and operation for the information of owners and drivers of gasoline cars. 2500 w. Automobile—Feb. 14, 1903. No. 53577.

Motor Vehicles.

Thornycroft Steam Wagon and Patrol Car. Illustrated description of two interesting vehicles shown at the Automobile exhibition in the Crystal Palace. 2500 w. Engng—Jan. 30, 1903. No. 53558 A.

Petrol Car.

The Chenard and Walcker 10-h. p. Patrol Car. An illustrated description of the general construction of an interesting car remarkable for silence when standing with the engine running, the absence of vibration when traveling, and other improvements. 1800 w. Auto Jour—Jan. 31, 1903. Serial, 1st part. No. 53596 A.

Racer.

America's Swiftest Car, the Baker Electric Racer. Hugh Dolnar. Briefly reviews the rapid development in motor vehicles, and gives an illustrated description of this machine, which claims a speed of 85 miles an hour. 2800 w. Autocar—Jan. 31, 1903. No. 53550 A.

Skidding.

Some Considerations Relating to Skidding Due to Changing the Direction of Motion. E. J. Stoddard. Considers the action of the wheels upon the roadbed, velocity of turning, forces created, etc. Ill. 2000 w. Horseless Age—Feb. 11, 1903. No. 53516.

Steam Vehicles.

A Retrospect of the Steam Vehicle. Hugh Dolnar. Reviews the history of the early attempts to propel vehicles by steam. 2200 w. Automobile—Jan. 31, 1903. No. 53399.

Reliability of Steam Cars in A. C. A. Contest. A comparison between the performances of steam and gasoline cars in the 500-mile reliability test from New York to Boston and return. 2000 w. Automobile—Feb. 14, 1903. No. 53576.

Steam Wagon. Illustrates and describes a wagon exhibited at the recent Crystal Palace show by the Straker Steam Vehicle Co. 1200 w. Engng—Feb. 13, 1903. No. 53695 A.

Touring Car.

The Locomobile Gasoline Touring Car. Illustrated detailed description of designs of A. L. Riker. 2800 w. Horseless Age—Feb. 18, 1903. Serial, 1st part. No. 53640.

Trials.

The Principal Automobile Trials of 1902 (Les Principales Epreuves Automobiles de 1902). F. Drouin. Giving tables of data and results of the more important tests of automobile vehicles during the year 1902. Two articles. 3000 w. Génie Civil—Jan. 24, 31, 1903. No. 53716 each D.

Winter.

Automobiling in Winter (Automobilfahren im Winter). Dr. Karl Dieterich. A discussion of the details of automobile construction necessary for satisfactory operation in cold weather and through snow. 2500 w. Zeitschr d Mitteleurop Motorwagen Ver—Jan. 31, 1903. No. 53781 D.

HYDRAULICS.

Electric Pumping.

See Electrical Engineering, Power Applications.

Elevators.

The Evolution of the Hydraulic Elevator: High-Pressure Elevators in the Prudential Buildings, Newark, N. J. Charles L. Duenkel. A brief historical retrospect with illustrated description of this important installation representative of modern practice. 6000 w. Eng News—Feb. 5, 1903. No. 53412.

Governor.

The Woodward Friction Water Wheel Governor. Illustrated detailed description of a recent design. 900 w. Ir Age—Feb. 4, 1903. No. 53371.

Hydraulic Power.

Precedents in Hydraulic Power Development. Editorial on the recent washout under the power house at Sault Ste. Marie, its cause and the repairs needed. Also discusses the construction of hydraulic works. 1800 w. Eng Rec—Feb. 21, 1903. No. 53835.

Hydro-Electric.

See Electrical Engineering, Generating Stations.

Plumbing.

Water Supply and Distribution in the New York Stock Exchange. Illustrated description of the principal features of this installation. 2100 w. Eng Rec—Feb. 14, 1903. No. 53639.

Pumping Engines.

See Mechanical Engineering, Steam Engineering.

Turbine.

Bucket Forms for the Francis Turbine (Die Schaufelung der Francis-Turbine). R. Escher. A mathematical study of the proportions and curvatures to be given to the buckets of the Francis type of hydraulic turbine. Two articles. 3000 w. Schweiz Bauzeitung—Jan. 17, 24, 1903. No. 53754 each B.

MACHINE WORKS & FOUNDRIES.

Balancing.

Balancing Rotating Parts. Warren E. Willis. Discusses unbalanced conditions and the conclusions that have been reached in regard to the method of correcting them. Ill. 1500 w. Am Mfr—Feb. 5, 1903. No. 53493.

Brass Foundry.

The New Brass Foundry of Siemens & Halske. Paul Wedver. Illustrated description of the new foundry at Charlottenburg, Germany, and its equipment. 3000 w. Foundry—Feb., 1903. No. 53363.

Camming.

Camming Automatic Screw Machines. Reprint of an article by W. A. Jeboult, published in the *Mechanical World*, explaining the principle and demonstrating the method of laying out the cams on the drums of screw machines. Ill. 2600 w. Mach, N Y—Feb., 1903. No. 53397 C.

Car Shops.

See Railway Engineering, Permanent Way and Buildings.

Casting Works.

The Largest Malleable Casting Plant in Europe. Bernhard Osann, in *Stahl und Eisen*. An illustrated description of the Gelsenkirch Casting Works, which claim to be the largest in the world. Their principal product is car wheels, particularly for small mine cars, and axle boxes for the same. 2500 w. Ir Age—Feb. 26, 1903. No 53827.

Cost Keeping.

See Industrial Economy.

Cranes.

Steam and Electric Cranes. Illustrated descriptions of a revolving steam crane having a capacity of 3 tons, and a 50-ton electric crane. 1800 w. Engng—Jan. 30, 1903. No. 53559 A.

Cupolas.

Modern Cupola Practice. F. W. Stickle. Notes the modification in the designs, and the advantages gained, and gives suggestions for rapid and economical melting. 1200 w. Foundry—Feb., 1903. No. 53365.

Finish.

Gun Metal Finish for Steel. B. L. Charles. Describes methods of producing this finish. 700 w. Am Mach—Feb. 12, 1903. No. 53531.

Foundry Management.

Foundry Management in the New Century. Robert Buchanan. Mr. Buchanan's fourth paper discusses the subject of materials of consumption including the purchase of coke, iron, sand, etc. 5000 w. Engineering Magazine—March, 1903. No. 53795 B.

Friction.

Friction in Machinery and Lubrication. D. B. Dixon. Describes tests, showing where the greatest amount of friction is to be found, and how to reduce it. 3000 w. Am Mfr—Feb. 5, 1903. No. 53492.

Gear Cutter.

Automatic Bevel Gear Generating Machine. Illustrated detailed description of a novel and interesting machine for generating theoretically correct bevel gears. 1900 w. Am Mach—Jan. 29, 1903. No. 53306.

Grinding.

Experiments on the Strength of Emery and Carborundum Wheels (Versuche über die Festigkeit van Schmirgel und Karbolundum-scheiben). M. Grübler. An account of experimental tests of the different binding materials used for the manufacture of grinding wheels. 5000 w. Zeitschr d Ver Deutscher Ing—Feb. 7, 1903. No. 53711 D.

Some Points About Grinding. C. H. Norton. On the selection of wheels for various classes of work, the things to be considered, and related matters. 3800 w. Am Mach—Feb. 5, 1903. No. 53448.

Knife Making.

Making the Press Button Knife. C. Neil. Illustrated description of a knife in which all the parts, excepting the blade, are made by machinery. Also describes the tools and methods. 2000 w. Am Mach—Feb. 5, 1903. No. 53446.

Milling Machines.

Milling Machine Feeds. Considers the usual methods of driving the feed of a milling machine, and the advantages of each: troubles that occur and their remedies: features, and desirable improvements. 3300 w. Engr, Lond—Jan. 30, 1903. No. 53560 A.

Molding.

Gates and Sprues. B. D. Fuller. Gives

some examples of improper gating, and discusses forms of gates and their uses. 1900 w. Ir Trd Rev—Feb. 5, 1903. No. 53417.

New Shops.

The Great West-Allis Plant of the Allis-Chalmers Company, Milwaukee, Wis. An illustrated description of an immense plant, nearly completed, for machine building. 3000 w. Mach, N Y—Feb., 1903 No. 53396.

The Witton Works of the General Electric Company, Limited. Plan, and illustrated detailed description of the works thus far developed. 3800 w. Elec Engr, Lond—Feb. 13, 1903. No. 53688 A.

The New Shops of the Armour Institute of Technology. G. F. Gebhardt. Illustrated description of this fine shop building, recently completed, in Chicago. 1000 w. Am Mach—Feb. 12, 1903. No. 53530.

Patterns.

The Use of Aluminum for Patterns. Harland Tuttle, in the *Aluminum World*. States some of the advantages due to the lightness of aluminum, and gives advice and suggestions in regard to its use. 1200 w. Foundry—Feb., 1903. No. 53366.

Sheet Metal.

Curling and Wiring Processes. Joseph V. Woodworth. Illustrates and describes press tools and fixtures for sheet metal work. The article is confined to tools for curling and wiring. 1000 w. Am Mach—Feb. 5, 1903. No. 53445.

Steel Castings.

See Mining and Metallurgy, Iron and Steel.

Steel-Works.

The Port Talbot Steel-Works and Their Equipment. Illustrated detailed description of these important works in South Wales. 2800 w. Ir & Coal Trds Rev—Feb. 6, 1903. No. 53620 A.

Tools.

Cutting Angles of Tools for Metal-Work as Affecting Speed and Feed. H. F. Donaldson. An account of experimental study to determine the best cutting angles for rapid cutting tool-steels. The experiments covered 14 different qualities of material. Ill. 4300 w. Inst of Mech Engrs—Jan. 16, 1903. No. 53370 D.

The Sub-Press. F. C. Fladd. Illustrated detailed description of a tool for punching very accurate work. 1000 w. Am Mach—Feb. 5, 1903. No. 53447.

Valuation.

The Valuation of Pig Iron for Foundry Purposes. Dr. Richard Moldenke. Discusses the opinions advanced in regard to the writer's suggestion for standard methods of valuing pig iron. 2000 w. Jour Am Found Assn—March, 1903. No. 53566.

MATERIALS OF CONSTRUCTION.

Abrasives.

Crushed Steel and Steel Emery. M. M. Kann. Read before the Am. Assn. for the Adv. of Science. Brief history of these products, their manufacture and uses. 2200 w. Ir Age—Jan. 29, 1903. No. 53305.

Aluminum.

Working Aluminum. H. Robinson. Considers the difficulties encountered, and how to avoid trouble. 900 w. Am Mach—Feb. 5, 1903. No. 53449.

Brass.

The Effect of Tellurium on Brass. Erwin S. Sperry. Experimental investigations of the influence of tellurium on the properties of brass. In small amounts it does not seem injurious; in comparatively large amounts it appears to impart cold-shortness to high-brass. 1400 w. Trans Am Inst of Min Engrs—Feb. & May, 1902. No. 53336.

Cast Steel.

See Mining and Metallurgy, Iron and Steel.

Expansion.

The Expansion of Tempered Steel (Sur la Dilatation des Aciers Trempés). MM. Charpy & Grenet. A discussion of the effect of the carbon content upon the coefficient of expansion. 1000 w. Comptes Rendus—Jan. 12, 1903. No. 53733 D.

Mercury.

An Effective Mercury Cleaning Device. A. O. Doane. Illustrates and describes a device which furnishes a reliable means of cleaning mercury for pressure gauges. 900 w. Eng Rec—Feb. 21, 1903. No. 53839.

Metallography.

See Mining and Metallurgy, Iron and Steel.

Nickel Steel.

Recent Investigations upon the Expansion of Nickel Steel (Nouvelles Recherches sur la Dilatation des Aciers au Nickel). C. E. Guillaume. Determinations of expansion coefficients of minimum-expansion alloys, with discussion of the influence of carbon silicon, and manganese upon the expansion. 1200 w. Comptes Rendus—Feb. 2, 1903. No. 53-737 D.

The Micrography of Nickel Steel (Sur la Micrographie des Aciers au Nickel). Léon Guillet. A discussion of the structure of various nickel steels as revealed by the methods of metallography. 1200 w. Comptes Rendus—Jan. 26, 1903. No. 53-736 D.

Steel Castings.

See Mining and Metallurgy, Iron and Steel.

Testing.

Drop Tests of Nicked Bars (Les Essais au Choc sur Barreaux Entailles). M. Abraham. A discussion of the methods of Barba and Frémont for determining the strength of metals by the drop test upon small nicked bars. Serial, part I. Revue Technique—Jan. 10, 1903. No. 53720 D.

New Viewpoints in the Testing of Materials (Ueber Einige Neuere Gesichtspunkte in Materialprüfungswesen). B. Zschokke. An examination of the progress which has been made in the testing of materials, including improved drop tests, chemical examination, metallography, etc. Two articles, 2500 w. Schweiz Bauzeitung —Jan. 31, Feb. 7, 1903. No. 53756 each B.

Tool-Steel.

The Taylor-White Process of Testing Tool-Steel. Report of the Committee on Science and the Arts on the invention of Maunsel White and Fred W. Taylor. 2500 w. Jour Fr Inst—Feb., 1903. No. 53-574 D.

Wire Testing.

A New Method of Testing Wire. Arthur Falkenau. A brief illustrated description of the Moore testing apparatus, with explanation of its use. 900 w. Pro Engrs' Club of Phila—Jan., 1903. No. 53675 D.

MEASUREMENT.

Computer.

The Screw-Propeller Computer. Illustrated description of a computer designed by Prof. McDermott, explaining its use. 700 w. Sib Jour of Mech Engng—Jan. 1903. No. 53660 C.

Contacts.

The Measurement of Contacts. Harvey D. Williams. Explains how such measurements can be made, and that when the method is applied to gear teeth it brings out facts of importance. Ill. 2500 w. Am Mach—Feb. 19, 1903. No. 53650.

Dynamometer.

A Transmission Dynamometer. Fred S. English. Illustrated description of a form of dynamometer similar in principle to the Webber Balance Dynamometer but differently applied. 600 w. Am Mach—Feb. 12, 1903. No. 53529.

Metric System.

Metric Measurements. Robert H. Smith. Reviews arguments presented in a recent debate before the British Inst. of Elec. Engrs., and gives the writer's views. 2800 w. Elec Rev, Lond—Feb. 13, 1903. No. 53690 A.

POWER & TRANSMISSION.

Belts.

Belting. W. D. Spooner. Considers the essentials of a good belt, the materials used, the placing in position and other points. 2800 w. Engr, U S A—Feb. 16, 1903. No. 53646.

Compressed Air.

Safe Ratios in Air Compression. Fred v. D. Longacre. On the determination of the maximum ratio of compression that can be used in a single cylinder with safety. Also editorial. Ill. 3500 w. Compressed Air—Feb., 1903. No. 53814.

Efficiency.

The Efficiency of Prime Movers and of Machines. An explanation of Prof. Rankine's method of determining efficiency. 1000 w. Engr, Lond—Jan. 23, 1903. No. 53461 A.

Gas Power.

The Blast Furnace as a Power Plant. Edward A. Uehling. Shows the importance of the blast furnace as a source of power and the efficiency of the gas engine as a prime mover. 3300 w. Stevens Ind —Jan., 1903. No. 53658 D.

The Direct Utilization of Furnace Gas for Power Generation (Die Direkte Verwertung der Gichtgase zur Energieerzeugung). H. Thimm. A general discussion of the use of furnace gas in large gas engines, with plate showing variations in speed and power. 3000 w. 1 plate. Glückauf—Feb. 7, 1903. No. 53747 B.

Grain Elevator.

A New Derrick or "Grasshopper" Elevator for Unloading Grain from Vessels. Illustrates and describes a machine in use at the London docks. 2000 w. Sci Am—Jan. 31, 1903. No. 53316.

Motor Power.

Census Report on Motor-Power Appliances. Edward H. Sanborn. Re-print of U. S. Census Report of statistics relating to the manufacture of appliances used for the generation of power, excluding locomotives and motor vehicles. 7800 w. Power—Feb., 1903. No. 53332 C.

Natural Sources.

Power from the Interior Heat of the Earth. William Hallock. Considers the amount of energy brought to the surface in the form of hot water from hot springs, and the temperatures of deep mines, etc., and discusses the utilizing the heat below the surface of the earth. Ill. 2200 w. Cassier's Mag—Feb., 1903. No. 53830 B.

Prony Brake.

Graphical Diagram for Brake Tests (Graphische Rechen tafel für Bremsversuche). Dr. F. Prasil. Constructing a diagram enabling the efficiency and load curves to be compared in Prony-brake tests of turbine water wheels. 600 w. Schweiz Bauzeitung—Feb. 7, 1903. No. 53757 B.

Rope Transmission.

Transmission with Endless Cables (Transmissions par Cables sans Fin). G. Mohr. A description of the American system of rope transmission, using an endless rope with several turns about the pulleys, and with a weighted tension idler. 1000 w. Génie Civil—Jan. 31, 1903. No. 53718 D.

Shafting.

Shafting Hints. Charles Herrman. Suggestions for remedying troubles. Ill. 3000 w. Power—Feb., 1903. No. 53330 C.

Torsion and Torsional Stresses in Propeller Shafts. Translations of a portion of a recent discourse by Mr. Hermann Frahm describing some interesting and novel experiments made investigating the dynamic forces acting in revolving propeller shafts. Ill. 3300 w. Engng—Feb. 6, 1903. No. 53617 A.

Spiral Gears.

Spiral Gears of Equal Diameters on Shafts at Right Angles. F. A. Halsey. Explanation, with practical examples. Supplementary to previous articles by the writer. 800 w. Am Mach—Feb. 19, 1903. No. 53651.

SPECIAL MOTORS.

Alcohol.

The Phenomena of Combustion in Stationary Alcohol Motors (Sur les Phénomènes de la Combustion dans les Moteurs Fixes à la Alcool). M. Sorel. An account of the laboratory investigations of the action of alcohol as a fuel in internal combustion motors at the exhibition at Paris in May, 1902. Serial, Part 1. 6000 w. Revue de Mécanique—Jan. 31, 1903. No. 53728 E + F.

Benzine Motor.

Comparative Tests of Benzine and Alcohol Motors (Vergleichende Versuche an einem Explosionsmotor mit Benzin und Spiritusbetrieb). A discussion of tests using the different fuels in the same engine under varying degrees of compression. 2500 w. Zeitschr d Ver Deutscher Ing—Jan. 10, 1903. No. 53702 D.

Gas Engines.

Brake Test of a Gas Engine. Alfred E. Lüders. Hints upon determining the horse power of an engine by what is commonly known as the brake mehod. 1200 w. Marine Engng—Feb., 1903. No. 53410 C.

Butler's Three-Cylinder Compound Gas Engine. Illustrated description of an engine of vertical type having novel features. 1000 w. Mech Engr—Jan. 31, 1903. No. 53551 A.

Gas Engines for Electric Lighting. H. B. Graham. Abstract of a paper read before the Birmingham Local Sec. of the Inst. of Elec. Engrs. and of the discussion. Discusses results obtained, the flywheel problem, balancing, bearings, etc. 3300 w. Elect'n, Lond—Jan. 30, 1903. No. 53554 A.

Sizes of Parts of Gas Engines. H. H. Kelley. Gives simple formulas for finding the sizes of parts based on the diameter of the cylinder within stated limits. Ill. 2200 w. Engr, U S A—Feb. 2, 1903. No. 53419.

Test of a Charon Gas Engine. R. Mathot. An account of tests made of an engine and producer gas power-plant installed at Winterthur (Switzerland). 900 w. Power—Feb, 1903. No. 53329 C.

Gas Fuels.

Gas Fuels for Modern Engines. George E. Walsh. Considers briefly the advance in engines of large units, those operated by natural gas; those adapted to use poor gas; and furnace gas engines. 2700 w. Ir Age—Jan. 29 1903. No. 53303.

Gasoline.

See Marine and Naval Engineering.

See Mechanical Engineering, Automobiles.

Internal Combustion.

Investigations upon Internal-Combustion Motors (Versuche mit Verbrennungsmotoren). Emil Schimanek. Discussing especially the improved Banki motor, in which a spray of water is injected into the charge. 4000 w. Zeitschr d Ver Deutscher Ing—Jan. 17, 1903. No. 53704 D.

STEAM ENGINEERING.

Blowing Engines.

Blowing Engines at the Priors Lee Furnaces. Illustration and drawings of a set of vertical compound blowing engines recently erected, the first, in England, fitted with positive valve gear and blowing at high pressure. Brief description. 500 w. Engr, Lond—Feb. 13, 1903. No. 53697 A.

Boiler Economy.

The Betterment of Steam-Boiler Economy. E. S. Farwell. An analysis of efficiency losses in steam generation, with suggestions for possible improvement. 2500 w. Engineering Magazine—March, 1903. No. 53796 B.

Boiler Explosions.

Lessons from Recent Steam Boiler Explosions (Einige Hauptlehren aus Dampfkesselexplosionen der jüngsten Zeit). C. Bach. A discussion of recent boiler explosions in Germany, with an analysis of causes. 2500 w. Zeitschr d Ver Deutscher Ing—Jan. 31, 1903. No. 53708 D.

Boiler Feeders.

Oil and Compound Feeders for Boilers. James F. Hobart. Illustrated discussion of appliances for feeding evenly. 1400 w. Am Electn—Feb., 1903. No. 53436.

Boilers.

Externally-Fired Boilers. William H. Fowler. States the advantages of external firing, considering two types of boilers. Ill. 1500 w. Mech Engr—Feb. 7, 1903. No. 53601 A.

Heating Boiler Development. H. J. Barron. Discusses heating boilers their merits and drawbacks. Ill. 1500 w. Engng Rev—Jan., 1903. No. 53322.

Modern Marine Boilers. A consideration of the Relative Advantages of Various Types. Discusses only those in use on at least a half-dozen steam vessels. 3200 w. Engrs' Gaz—Feb. 1903. Serial, 1st part. No. 53603 A.

The Efficiency of Boiler Furnaces. Extracts from a memorandum recently issued by C. E. Stromeyer, dealing with matters relating to the working of steam boilers. 3500 w. Mech Engr—Feb. 14, 1903. No. 53681 A.

Water-Tube Naval Boilers. Concerning the Admiralty trials of the gunboat Sheldrake and sloop Espiegle, fitted with Babcock and Wilcox water-tube boilers; and the Seagull and Fantome, fitted with the Niclausse water-tube boilers. 2200 w. Engrs' Gaz—Feb., 1903. No. 53602 A.

Chimneys.

Chimney Notes. William Wallace Christie. Illustrated description of the tearing down of a large chimney in Paterson, N. J., and considers various features of brick chimneys. 1500 w. R R Gaz—Feb. 13, 1903. No. 53545.

Combustion.

Combustion. W. D. Spooner. Gives results of some experiments made in an attempt to secure economy. 5400 w. Engr, U S A—Feb. 16, 1903. No. 53647.

Condenser.

The Central Condensation Plant of the Heinitz Mine at Saarbruck (Die Zentral Kondensation der Königlichen Heinitzgrube bei Saarbrücken). G. W. Koehler. Illustrated description of a central condensing plant with Klein cooling towers, for handling 12,000 kilogrammes of steam per hour. 2000 w. 1 plate. Glückauf—Jan. 17, 1903. No. 53741 B.

Engines.

A New High-Speed Engine. Illustrated description of Hoy's high-speed, single-acting, compound engine, which is extensively used on the Lancashire and Yorkshire Railway. 800 w. Engr, Lond—Jan. 30, 1903. No. 53563 A.

Some Steam Engine Installations at Twente (Einige Machine-Installaties Uitgevoerd in Twente). E. Looman. With illustrations of compound engines recently installed in textile works of Gronan, Ryssen, and Borne, Holland. 2500 w. 3 plates. De Ingenieur—Jan. 24, 1903. No. 53738 D.

Entropy.

Entropy: An Elementary Exposition. Sir Oliver Lodge. An article in response to a special request explaining this term of thermodynamics. 5000 w. Elect'n, Lond—Jan. 23, 1903. No. 53472 A.

Entropy. Prof. H. Poincaré. A contribution to the controversy about entrophy. 2700 w. Elect'n, Lond—Feb. 13, 1903. No. 53692 A.

Entropy. Prof. John Perry. The writer's explanation of the term. 1800 w. Engr, Lond—Jan. 23, 1903. No. 53460 A.

Entropy. Robert H. Smith. A contribution to the discussion of this term, especially referring to the paper by Prof. John Perry. 1600 w. Engr, Lond—Jan. 30, 1903. No. 53562 A.

Flywheels.

A Convenient Rule for Computing Maximum Revolutions for Flywheels. William H. Boehm. From the monthly bulletin of the Fidelity & Casualty Co. Gives a rule based upon the practice of allowing a rim-speed of one mile per minute for well-made cast-iron wheels. 200 w. Eng News —Jan. 29, 1903. No. 53308.

Governors.

The Theory of Steam-Engine Governors (Note sur la Théorie des Régulateurs). V. Dwelshauvers-Dery. An examination of the conditions of isochronous regulation of steam engine speed by centrifugal governors, and the extent to which it can be attained in practice. 8000 w. Revue Mécanique—Jan. 31, 1903. No. 53727 E + F.

Horse-Power.

Boiler Horse-Power for Heating and Power. Charles L. Hubbard. Gives methods of computing, based on 15 sq. ft. per H. P. 1800 w. Mach, N Y—Feb., 1903. No. 53398.

Indicators.

Notes on the Testing of Indicator Springs (Beiträge zur Prüfung von Indikatorfedern). H. F. Wiebe & R. Schwirkus. A discussion of the methods for testing indicators used at the Reichsanstalt and advocating the placing of the spring out of contact with the steam. 3500 w. Zeitschr d ver Deutscher Ing—Jan. 10, 1903. No. 53701 D.

Typical Examples of Defective Indicator Diagrams. Extract from a paper by A. Marshall Arter read before the Civ. & Mach. Engrs' Soc. Valuable notes on defective indicator diagrams, with the causes that produced them. 4500 w. Mech Engr—Jan. 24, 1903. No. 53466 A.

Oil Fuel.

Notes on Burning Crude Oil in Scotch Boilers. H. S. Markey. Suggestions for the successfud burning of oil, noting the troubles experienced. 1300 w. Marine Engng—Feb., 1903. No. 53405 C.

Oil Separator.

The Relation of the Efficiency of an Oil Separator to the Quality of Oil Used (Abhangigkeit der Wirksamkeit des Oelabschneiders von der Beschaffenheit des den Dampfzylindern Zugeführten Oeles). C. Bach. A brief account of tests upon a separator showing the variations in results obtained by feeding different oils into the steam cylinder. 1000 w. Zeitschr d Ver Deutscher Ing—Feb. 7, 1903. No. 53712 D.

Piping.

High Pressure Steam Piping. William Andrews. Read before the Engine Builders' Assn. Discusses the design, the quality of the material, and the disposing of the water. 2400 w. Met Work—Feb. 14, 1903. No. 53532.

Pipe Fittings. John H. Ryan. Suggestions with illustrations. 1800 w. Engr, U S A—Feb. 2, 1903. Serial, 1st part. No. 53420.

See also Marine Engineering.

Pumping Engines.

Maximum Duty of a Pumping Engine with 1,000 Pounds of Steam. A. F. Nagle. A calculation of the duty of an ideal engine under practical conditions. 1700 w. Engr, U S A—Feb. 2, 1903. No. 53421.

Safety-Valves.

Safety-Valve Springs. H. K. Spencer. Gives formulas for both round and square steel and considers how such springs are proportioned. 600 w. Marine Engng—Feb., 1903. No. 53406 C.

Speed.

Changing the Speed of Engines. W. H. Wakeman. An explanation of the principles involved. Ill. 900 w. Power—Feb., 1903. No. 53331 C.

Steam Heating.

General Rules for Low-Pressure Steam Heating (Zur Erzeilung der Generellen Regetung der Niederdruck dampfheizungen). H. Rietschel. A development of working formulas with examples of their practical application. 6000 w. Gesundheits-Ingenieur—Jan. 31, 1903. No. 53788 B.

Steam Turbines.

Steam Turbines for the Massachusetts Electric Companies. Illustrates and describes details of the installation at Newport, R. I. 1800 w. Steam Engng—Feb. 10, 1903. No. 53528.

Steam Turbines of the Massachusetts Electric Companies. Plans and general description of this new steam turbine power plant. The first plant to receive the turbine equipment is at Newport, R. I. 1800 w. St Ry Rev—Feb. 20, 1903. No. 53820 C.

Steam Turbines for Power Stations and Factories. Abstract of a paper read before the Manchester Assn. of Engrs. The present article gives an illustrated description of the action of the De Laval steam turbine. 2200 w. Prac Engr—Feb. 6, 1903. Serial, 1st part. No. 53594 A.

The Steam Turbine. H. M. Gleason. States the general advantages over the reciprocating engine, and the special advantages for the propulsion of ships. 1500 w. Sci Am—Feb. 21, 1903. No. 53822.

Superheating.

The Advantages and Disadvantages of the Superheated-Steam Locomotive (Für und Wider die Heissdampflokomotiv). H. Teuscher. A discussion of the Schmidt locomotive, comparing its economy with the modern compound locomotive. 2500 w. Zeitschr d Ver Deutscher Ing—Jan. 24, 1903. No. 53707 D.

Valve Gears.

Recent Valve Gear Devices (Sur Quelques Dispositions Récentes de Distributions par Soupapes). M. Svilokossitch. Illustrating and describing recent poppet valve gears for steam engines. Serial, Part I. 2000 w. Revue Technique—Jan. 25, 1903. No. 53721 D.

MISCELLANY.

Aeronautics.

The Airship System of M. Frederick L'Hoste. Dr. T. Byard Collins. Brief illustrated description. 1200 w. Sci Am Sup— Feb. 14, 1903. No. 53535.

Artillery.

A Sketch of the Origin and Development of Artillery. W. J. Peirce. Considers those engines employing gunpowder, or a similar explosive agent, as a propelling force; also the carriage, the powder and projectiles. 6000 w. Yale Sci M—Jan., 1903. No. 53301 C.

Test of the New 16-Inch Gun. An account of the test of the new United States army 16-inch gun at the Sandy Hook proving ground. Ill. 1100 w. Sci Am—Jan. 31, 1903. No. 53315.

Mechanics.

The Evolution of Mechanics (L'Evolution de la Mécanique). P. Duhem. A review of the history of the growth of the study of mechanics, from the earliest times to the present. Serial, Part I. 5000 w. Rev Gen des Sciences—Jan. 30, 1903. No. 53729 D.

Refrigeration.

A Calcium Chloride Cooler. J. A. Mermilliod. Gives the writer's experience in overhauling a poorly equipped ice plant and connecting cold storage department, and illustrates and describes the cooler. 1200 w. Ice & Refrig—Feb. 1903. No. 53451 C.

Slide Rule.

Mechanical Aids to Computation (Einige Hulpmiddelen voor hel Rekenen). F. J. Vaes. A description of the improved slide rule and tables of Proell for facilitating numerical computations. 3000 w. De Ingenieur—Feb. 7, 1903. No. 53740 D.

Type-Setting.

The Inventions of Dr. William Church—The First Patented Type-Casting and Composing Machine. Illustrates and describes a machine patented in 1822. 2300 w. Sci Am—Feb. 14, 1903. No. 53534.

MINING AND METALLURGY

COAL & COKE.

Anthracite.

The Anthracite Situation. Robert Lincoln O'Brien. A discussion of coal prices and the systems regulating them; causes of shortage; the attitude of operators and miners, etc. 1600 w. Eng & Min Jour—Jan. 31, 1903. No. 53440.

The Welsh Anthracite Coal Trade. An interesting article giving much information in regard to the collieries, deposits, etc., in Wales, as well as discussing the trade. 3500 w. Ir & Coal Trds Rev—Jan. 23, 1903. No. 53464 A.

Briquetting.

The Briquetting of Flue Dust, Fine Ore and Fuel. Considers this method of utilizing fine material, the machines used, and the results. Ill. 9500 w. Eng News—Feb. 12, 1903. No. 53537.

Bunkers.

Coal-Bunker Plant at a German Colliery. Stach, in *Glückauf*. Brief description with illustration of the plant and its operation. It is claimed to give economical results and cleanliness. 600 w. Col Guard—Jan. 23, 1903. No. 53458 A.

Coal-Cutting.

Notes on Coal-Cutting by Machinery. A. Dury Mitten.. Abstract of paper and discussion before the Manchester Geol. Soc. Considers the circumstances under which coal-cutting machines can be adopted; what machine and motive power is best: and the benefit. 2300 w. Ir & Coal Trds Rev—Feb. 13, 1903. No. 53-800 A.

Coal Tariff.

See Industrial Economy.

Coal-Washing.

Coal-Washing Plant at an Austrian Colliery. H. Hoefer, in *Oesterreichische Zeitschrift für Berg- und Huttenwesen.* Illustrated description of a plant using the Elliott system with six troughs. 900 w. Col Guard—Jan. 23, 1903. No. 53457 A.

Coking.

Coking in Bee-Hive Ovens with Reference to Yield. Charles Catlett. A discussion of the factors affecting the yield. 3300 w. Am Gas Lgt Jour—Feb. 2, 1903. No. 53390.

Deposits.

The Coal Deposits of the Northwest. Frank A. Wilder. Gives an account of the extensive deposits of bituminous coal and lignite, although no anthracite has been found. 2500 w. Rev of Revs—Feb., 1903. No. 53357 C.

Lignites.

The Fuel Value of the North Dakota Lignites. Frank A. Wilder. Information in regard to the quality, the uses to which it may be applied, results of tests, etc., Ill. 2000 w. Eng & Min Jour—Feb. 7, 1903. No. 53512.

New Zealand.

The Buller Coalfields (N. Z.) Sydney Fry. Information of their extent and quality, and their probable continuity beyond the limits prospected. 1100 w. Aust. Min Stand—Jan. 1, 1903. No. 53598 B.

Rocky Mountains.

The Efficiency of Some Rocky Mountain Coals. W. H. Williams. Read before the Montana Soc. of Engrs. Describes tests made of these coals, and gives results. 1600 w. Jour Assn of Engng Socs—Dec., 1902. No. 53664 C.

COPPER.

Arizona.

Developments Near Bisbee, Arizona. D. E. Woodbridge. Report of this valuable copper district. 1200 w. Eng & Min Jour—Feb. 7, 1903. No. 53513.

The Verde Mining District, Yavapai County, Arizona. Illustrated description of this famous copper mining district.

1300 w. Min & Sci Pr—Jan. 31, 1903. No. 53485.

Copper Slag.

Report on a Co-operative Chemical Analysis of a Copper Slag. Thorn Smith. Gives the methods of analysis and results, discussing them in detail. 4500 w. Eng & Min Jour—Feb. 21, 1903. No. 53815.

Extraction.

The Elimination of Arsenic, Antimony and Bismuth from Copper. Allan Gibb. A study of the elimination effected in the various metallurgical operations. 4800 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 53334 D.

New Mexico.

The Copper-Deposits of the Sierra Oscura, New Mexico. H. W. Turner. Describes these deposits and discusses the commercial value of the ore. 1300 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 53338.

Nickel-Copper.

Note of the Condition of Platinum in the Nickel-Copper Ores from Sudbury Charles W. Dickson. Gives results of experimental investigations. 1100 w. Am Jour of Sci—Feb., 1903. No. 53369 D.

Santiago de Cuba.

El Cobre Copper Mines, Santiago de Cuba. A. E. Heighway. A brief account of the history and present development of these mines which produced $48,000,000 during a period of 18 years. Ill. 1000 w. Eng & Min Jour—Feb. 7, 1903. No. 53510.

South Africa.

Copper in Rhodesia, South Africa. Reviews the reports of T. G. Davey and J. F. Jones, and discusses the prospects. 2500 w. Ir Age—Feb. 19, 1903. No. 53625.

Sweden.

Recent Discoveries of Copper Ore in Norrbotten (Neue Kupfererzfunde in Norrbotten). E. Svedmark. A brief account of the recent discoveries of copper ore in the extreme north of Sweden. 600 w. Glückauf—Jan. 31, 1903. No. 53745 B.

GOLD AND SILVER.

Assaying.

An "All-Fire" Method for the Assay of Gold and Silver in Blister-Copper. Walter G. Perkins. Describes the process used and states the advantages of the method. 1500 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 53341 C.

Central America.

Copper, Silver, and Gold in Central America. Reports concerning Honduras, Nicaragua and Salvador. 2500 w. U S Cons Repts, No. 1565—Feb. 7, 1903. No. 53426 D.

Chile.

Copper, Silver and Gold in Chile. A report of the mineral resources and mining industry. 2800 w. U S Cons Repts, No. 1564—Feb. 6, 1903. No. 53401 D.

Concentration.

A Modern Coarse Concentration Plant for Silver Lead Ore. Ernest R. Woakes. Read before the Inst. of Min & Met. An illustrated detailed description of the Highland Concentrator at Ainsworth, B. C. with information of the capacity and cost of operation. 5400 w. Can Min Rev —Jan. 31, 1903. No. 53387 B.

The Concentration of Ores by Oil. Walter McDermott. A description of the Elmore process. Ill. 1500 w. Eng & Min Jour—Feb. 14, 1903. Serial. 1st part. No. 53632.

The Elmore Process of Concentration by Oil. W. H. Booth. Describes this method adapted for saving finely divided floating particles of ore or metal. 2000 w. Mines & Min—Feb., 1903. No. 53-517 C.

Cyanide.

Notes on Commercial Cyanide of Potash. A. Whitby. Report of investigations made showing how wide the difference may be in the composition while still retaining the percentage claimed. 1100 w. Jour Chem & Met Sci of S Africa—Dec. 1902. No. 53590 E.

Notes on the Analysis of Cyanide Solutions. A letter from W. H. Virgoe, in contribution to the discussion of a paper by Andrew F. Crosse. 1200 w. Jour Chem & Met Soc. of S Africa—Dec., 1902. No. 53589 E.

The Cyanide Process in Montana. Matt. W. Alderson. Abstract of a report to the Bureau of Agriculture, Labor. and Industry, Montana. Gives statistics of production by cyanide since 1896, showing increase. 900 w. Eng & Min Jour—Feb. 7, 1903. No. 53511.

Dry Ores.

The Dry Ores of Slocan, B. C. Ronald C. Campbell-Johnston. Describes these deposits, the characteristics of the ores, and the treatment they require. Gold is carried in arsenides and sulphides of iron; the silver occurs native, or as sulphides, or alloyed. 800 w. Min & Sci Pr—Jan. 24, 1903. No. 53377.

Georgia.

The Dahlonega Gold District of Georgia. Edwin C. Eckel. Gives the general geology of the region, the ores and ore-deposits and related information. 2500 w. Eng & Min Jour—Feb. 7, 1903. No. 53509.

Mexico.

Notes on Certain Mines in the States of Chihuahua, Sinaloa and Sonora, Mexico.

Walter Harvey Weed. Observations made during recent trips, giving a description of the geology of this region famous for its gold and silver mines. Ill. 12400 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 53346 D.

The Mining District of Parral, State of Chihuahua, Mexico. G. A. Burr and Louis S. Cates. The first of a series of articles aiming to give a concise review of this promising region, which has been mined for several centuries for gold and silver ores. Map. 1800 w. Eng & Min Jour—Feb. 7, 1903. Serial, 1st part. No. 53507.

Milling.

Mill of the Melones Mining Co. at Melones, Calaveras County, Cal. Walter W. Bradley. Illustrates and describes the milling equipment. The plans call for 120 stamps and 60 have been in operation since April, 1902. 1500 w. Min & Sci Pr—Jan. 24, 1903. No. 53376.

Mining Reports.

Copper, Silver, and Gold in the Argentine Republic and Brazil. Reports from consular officers in Latin America on mining in their districts. 3000 w. U S Cons Repts, No. 1562—Feb. 4, 1903. No. 53-372 D.

Mongolia.

Silver-Mining and Smelting in Mongolia. Yang Tsang Woo. Describes the methods employed by the natives. Ill. 1200 w. Trans Am Inst of Min Engrs—Feb. & May, 1902. No. 53337.

Ore-Deposits.

Basaltic Zones as Guides to Ore-Deposits in the Cripple Creek District, Colorado. E. A. Stevens. Describes the rock-types and the dike of quartz-porphyry associated with all the paying mines of this district, considering them as the true and only guides to the opening of mines in Cripple Creek. 3800 w. Ill. Trans Am Inst of Min Engrs—Feb. and May, 1902. No. 53343 C.

Panning.

How to Pan Gold from Gravel. Taken from the printed instructions, by Prof. Henry S. Monroe, for students in the ore dressing laboratory of the School of Mines. Columbia Univ., New York. 1200 w. Eng News—Feb. 12, 1903. No. 53638.

Precipitation.

Precipitation of Coppery Cyanide Solutions. R. Stuart Browne. Points from the writer's experience in leaching ores containing copper. 1200 w. Min & Sci Pr—Jan. 24, 1903. No. 53378.

Smelting.

The Lead Smelting of Zinc Gold Slimes. Continued discussion of paper by P. S. Tavener. 2000 w. Jour Chem & Met Soc of S Africa—Dec., 1902. No. 53592 E.

Sorting.

Sorting at Johannesburg. T. Lane Carter. A brief account of a test being tried where no attempt is made to sort out the waste. 1200 w. Eng & Min Jour—Feb. 7, 1903. No. 53506.

Valuation.

Notes on Valuing a Gold Mine. T. Lane Carter. Mr. Carter's reply to the discussion on his paper. 3000 w. Jour Chem & Met Soc of S Africa—Dec., 1902. No. 53593 E.

Wales.

Gold Mining in Wales. W. H. Booth. An illustrated review of Welsh gold mining, the methods used for the extraction of the gold, history of the various mines, their equipment, and matters of related interest. 5600 w. Cassier's Mag—Feb., 1903. No. 53828 B.

Witwatersrand.

The Equipment of the Bonanza Mine, Johannesburg. Edgar Smart. The first of a series of illustrated articles dealing with the gold-mining plants of the Rand. Especially noticing the points in which plants differ, and improvements in detail of plant or practice. 4000 w. Page's Mag—Feb., 1903. No. 53833 B.

IRON AND STEEL.

Blowing Engines.

See Mechanical Engineering, Steam Engineering.

Cast Steel.

Blow Hole and Pipe Formations in Cast Steel. H. Diederichs. An illustrated review of a paper by A. Von Dormus, describing methods used by the steel works at St. Etienne, and the work of J. A. Brinell. 1400 w. Sib Jour of Mech Engng—Jan., 1903. No. 53661 C.

Desulphurizing.

Manganese Ore as a Desulphurizing Agent in Basic Open Hearth Practice. A. Riemer, in *Stahl und Eisen*. Gives results of experiments showing the influence of manganese ore and its value as a desulphurizing agent, and giving related facts and tests of importance. 1600 w. Ir Age—Jan. 29, 1903. No. 53304.

Electric Driving.

See Electric Engng. Power Applications.

Fuel.

The Use of Sulphur-Bearing Fuel in the Blast Furnace (Ueber die Verwendung Schwefelreicher Brenstoffe im Hochofen). Oskar Simmersbach. With tables showing the influence of sulphur in the fuel upon the iron for various ores. 1500 w. Stahl u Eisen—Feb. 1, 1903. No. 53761 D.

Furnace Gas.

See Mechanical Engng. Power and Transmission.

Iron Ore.

An Ontario Iron Ore Deposit. Two articles giving information in regard to the deposits of the Hutton Iron Range. 2200 w. Eng & Min Jour—Jan. 31, 1903. No. 53439.

Lake Superior.

The Iron Ore Trade of the Lake Superior Region for the Year 1902. Horace J. Stevens. Reports the largest output ever made in one year. 2800 w. Mines & Min —Feb., 1903. No. 53522 C.

Metallography.

General Method for the Micrographic Analysis of Steel. F. Osmond. Translated from the French. Gives a full description of methods from the preparation of samples, a study of the constituents, and detailed examination of a few steels with illustrations. 13000 w. Pro Engrs' Soc of W Penn—Dec., 1902. No. 53666 D.

New Micrographic Constituents Upon the Surface of Hardened Steel (Neue Mikrographische Gefügedestandteile auf der Oberflache des Gehärtelen Stahls). W. Ischewsky. With reproductions of microphotographs showing the structure of various hardened steels. 1200 w. 1 plate. Stahl u Eisen—Jan. 15, 1903. No. 53760 D.

The Use of the Microscope in the Determination of the Properties of Steel. Prof. Albert Sauveur. An illustrated article showing the value of the science of metallography, especially considering iron and steel. Also discussion, and paper by W. J. Beck on "The Preparation of Samples for Microscopic Analysis, etc." 9900 w. Pro Engrs' Soc of W Penn—Dec., 1902. No. 53665 D.

Minnesota.

The Vermillion Iron Range in Minnesota. D. E. Woodbridge. A brief account of the exploration in progress. 900 w. Eng & Min Jour—Feb. 14, 1903. No. 53631.

Steel Castings.

The Manufacture and Applications of Steel Castings (Stahlformguss und Seine Verwendung). Bernhard Osann. A discussion of the present state of the art of making steel castings in the light of the exhibits at the Düsseldorf exposition. Stahl u Eisen—Jan. 15, 1903. No. 53759 D.

Steel Ingots.

Classifying Steel Ingots, and the Influence of Chemical Composition on Their Solidity. From *Stahl und Eisen*. An illustrated article describing various types of ingot and giving the classification made by J. A. Brinell. 1500 w. Ir Age—Feb. 19, 1903. No. 53624.

Steel Works.

See Mechanical Engineering, Machine Works and Foundries.

Tin Plate.

The Manufacture of Tin Plate. B. E. V. Luty. Read before Calvary Church Brotherhood, Pittsburg. A review of the processes used in this industry, describing the manufacture. 3600 w. Met Work—Feb. 14, 1903. No. 53533.

Tool Steel.

See Mechanical Engineering, Materials.

Utah.

Notes on Southwestern Utah and Its Iron Ores. G. C. Hewitt. Read before the Colorado Sci. Soc. Describes this interesting region, giving details and impressions obtained during recent visits. 3300 w. Min Rept—Feb. 12, 1903. No. 53633.

MINING.

Analysis.

Modern Methods of Rock and Mineral Analysis. Dr. W. F. Hillebrand. An outline of present practice, showing why it differs from earlier times. 5800 w. Jour Fr Inst—Feb., 1903. Serial. 1st part. No. 53573 D.

Deep Mining.

Deep Mining Will Bring Success—Something About Geological Formations in New Mexico. C. H. Laidlaw. A study of the geology, giving reasons for believing valuable minerals may be found at great depths. 1000 w. Min Rept—Feb. 5, 1903. No. 53497.

Electric Hoisting.

See Electrical Engineering, Power Applications.

Electric Pumping.

See Electrical Engineering, Power Applications.

Explosion.

The Abertysswg Colliery Explosion. Reported by Mr. S. T. Evans and J. S. Martin on the circumstances attending this explosion, which occurred at Mac Laren Colliery, Sept. 3, 1902. 8500 w. Col Guard—Jan. 30, 1903. Serial. 2 parts. No. 53557 each A.

The Gas Explosion at the Doblhoff Shaft at Modlan (Die Brandgas Explosion auf dem Doblhoff III Schachte in Modlan). Adolf Hummel. A detailed account of the disastrous mine explosion at Modlan., near Brüx, Bohemia, on April 30, 1902. Serial, Part I. 2000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 7, 1903. No. 53749 D.

Explosives.

The Protection of Explosive Magazines from Lightning. Notes embodying the recommendations of an official commission appointed in Belgium to consider the best means of protection. 2000 w. Col Guard—Feb. 6, 1903. No. 53611 A.

The Theory of Misfires and Some Conclusions of Practical Value. Continued discussion of paper by E. H. Weiskopf. 1700 w. Jour Chem & Met Soc of S Africa—Dec., 1902. No. 53591 E.

Hoisting.

The Installation of a Cable for a Koepe Hoisting Plant (Das Auflegen der Seile bei Koepe Fördermaschinen). K. I. Müller. Describing the method of drawing a new cable through the sheaves and drums of a double mine hoist by means of a temporary auxiliary cable and winding drum. 1000 w. Glückauf—Jan. 17, 1903. No. 53742 B.

Mexico.

Notes on a Section Across the Sierra Madre Occidental of Chihuahua and Sinaloa, Mexico. Walter Harvey Weed. Diagrammatic section, with notes on the geological features. 6000 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 53335 D.

The District of Hidalgo Del Parral in 1820. Norberto Dominguez. History of this mining region, abstracted from the report of a commission appointed to investigate the conditions. 7200 w. Trans Am Inst of Min Engrs—Nov. 1902. No. 53347 C.

Mining Management.

The General Management of Metalliferous Mines. Albert Williams, Jr. The concluding article of the series discusses the methods of increasing the efficiency of the management staff by a suitable division of duties. 3500 w. Engineering Magazine—March, 1903. No. 53793 B.

New Mexico.

The Ore-Deposits of the San Pedro District, New Mexico. Morrison B. Yung, and Richard S. McCaffery. Maps and illustrations showing the general geology of the region, with description of the deposits of copper lead-silver and gold. 3500 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 53345 C.

Ore Deposits.

A Consideration of Igneous Rocks and Their Segregation or Differentiation as Related to the Occurrence of Ores. J. E. Spurr. A study of principles involving the connection of igneous rocks with ore deposition. 18800 w. Trans Am Inst of Min Engrs—Feb. & May, 1902. No. 53333 D.

Igneous Rocks and Circulating Waters as Factors in Ore-Deposition. J. F. Kemp. Discusses the views of Prof. Van Hise and other writers, and gives reasons for differing in some of the conclusions, especially in regard to deep mines. 6000 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 53344 C.

The Genetic Classification of Ore-Bodies. Gives a classification proposed by W. H. Weal, and report of the discussion. 4800 w. Eng & Min Jour—Feb. 14, 1903. No. 53630.

The Sierra Mojada, Coahuila, Mexico, and its Ore Deposits. S. F. Emmons. A contribution of the discussion of the paper of James W. Malcolmson. 800 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 53339.

Pit Heads.

The Bentrop System of Airtight Pit Head Casings. Illustrated detailed description of this type of construction, with particulars of its operation. 3300 w. Ir & Coal Trds Rev—Jan. 23, 1903. No. 53465 A.

Sampling.

The Sampling and Estimation of Ore in a Mine. T. A. Rickard. The first of a series of articles giving details of personal practice, and containing valuable information. Ill. 3000 w. Eng & Min Jour—Feb. 7, 1903. Serial, 1st part. No. 53505.

Shaft Sinking.

Shaft-Sinking Through Water-Bearing Strata. Indicates various methods that have been adopted or proposed for dealing with exceptional quantities of water under difficult circumstances. 5000 w. Ill. Col Guard—Jan. 30, 1903. No. 53556 A.

The Deepening of Two Ventilating Shafts of the Bruch, Bohemia, Coal Mines (Ueber das Abteufen zweier Wetterschachte in Brucher Grubenfelde). A. Padour. A description of the method employed in deepening two ventilating shafts without interruption of the air flow, with log of the progress of the work. Three articles, 2 plates. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 17, 24, 31, 1903. No. 53748 each D.

Shot Firing.

The Management of Shot-Firing in Coal Mines. Suggests rules which, if enforced, the writer believes would reduce accidents from this cause to a minimum. 2000 w. Col Guard—Feb. 6, 1903. No. 53612 A.

Timber.

The Utilization of Pit Tips for the Growing of Pit Timber. Abstract of a paper by Mr. Herbert Stone before the So. Staffordshire Iron & Steel Inst. Showing that trees can be grown on these pit mounds to advantage. 3500 w. Col Guard—Jan. 23, 1903. No. 53459 A.

Valuation.

Examination and Valuation of Mines. Prof. Arthur Lakes. Discusses the use of the term "ore in sight," the difference between a "mine" and a "prospect," and other matters. Also editorial. 5800 w. Mines & Min—Feb., 1903. No. 53521 C.

MISCELLANY.

Borax.

American Borax Mines. Don Maguire. An account of the discovery of this mineral in the deserts of California and Nevada, and the methods of transporting and preparing it. 3800 w. Mines & Min—Feb., 1903. No. 53519 C.

Fluor Spar.

The Fluor Spar and Zinc Mines of Kentucky and Illinois. F. H. Harwood. Begins an illustrated detailed account of the mines of this district. 1000 w. Min & Sci Pr—Feb. 7, 1903. Serial, 1st part. No. 53575.

Lead.

Lead Refining in Trail, B. C. An illustrated description of a refinery using the Betts Electrolytic process. 1300 w. Can Min Rev—Jan. 31, 1903. No. 53385 B.

Petroleum.

Principles controlling the Geologic Deposition of the Hydrocarbons. George I. Adams. Also discussion by David T. Day. A discussion dealing more particularly with deposits of gas and oil which have resulted from underground circulation. 4000 w. Trans Am Inst of Min Engrs—Feb. & May, 1902. No. 53342 C.

The Boulder Oil-Field, Colorado. J. E. Kirkbride. A brief account of this district, the wells, the yield, etc. 900 w. Eng & Min Jour—Feb. 7, 1903. No. 53508.

Salt.

Evaporated Salt Industry in Kansas. W. R. Crane. An illustrated article describing the works where salt is made from brines, reporting concerning the output, value, methods, etc. 3000 w. Eng & Min Jour—Feb. 7, 1903. No. 53514.

Tin.

The Pioneer Tin Mine (T.). Illustration, with description of the deposits of north-east Tasmania. 3000 w. Aust Min Stand—Jan. 1, 1903. Serial, 1st part. No. 53599 B.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in December. Condensed record of the principal accidents, with editorial comments on the more serious. 4000 w. R R Gaz—Feb. 13, 1903. No. 53546.

Automatic Control.

Automatic Electrically Controlled Engines. George E. Walsh. Brief description of automatic train controlling systems which seem promising. 1500 w. Elec Rev, N Y—Feb. 7, 1903. No. 53490.

Braking.

Braking and Traction Brakes. Charles F. Scott. Introductory remarks to a series of papers on this subject. 800 w. Trans Am Inst of Elec Engrs—Jan., 1903. No. 53667 D.

Railroad-Car Braking. R. A. Parke. A sketch of the practical development of brakes in railroad service; an analysis of the results of investigations of brake-shoe friction; brake efficiency, etc. The peculiar characteristics of the magnetic brake are also briefly described. Ill. and discussion. 26,000 w. Trans Am Inst of Elec Engrs—Jan., 1903. No. 53669 D.

Some Brake-Tests and Deductions Therefrom. J. D. Keiley. A description of a method of making brake-tests, and of a recording apparatus used in this method; also results from tests on varieties of brakes, and an empirical equation showing the operation of these brakes under different conditions. Ill. 2800 w. Trans Am Inst of Elec Engrs—Jan., 1903. No. 53668 D.

Collision.

The Westfield Collision. An editorial discussion of means of preventing rear collisions, and some particulars in regard to the accident. 5000 w. R R Gaz—Feb. 6, 1903. No. 53424.

Fuel.

Economical Use and Accounting Methods for Handling Fuel for Locomotives. F. A. Healy. Read before the Southern & Southwestern Ry. Club. Considers mainly the accounting and its difficulties. 2800 w. Ry Age—Feb. 6, 1903. No. 53499.

MOTIVE POWER & EQUIPMENT.

Cars.

A Quarter of a Century of Car Building. States some of the conditions existing twenty-five years ago, reviewing the development of the freight car. 5400 w. Ry Mas Mech—Feb., 1903. No. 53802.

Development of the Railroad Car. Eugene Chamberlin. Recalls the peculiarities of early freight and passenger cars, and the improvements introduced. 1200 w. Loc Engng—Feb., 1903. No. 53403 C.

Is the 10-Ton Wagon the Best After All. Compares British and American practice, and considers the 10-ton type the most suitable for the traffic in England. Also discusses other matters affecting the cost of haulage. 2800 w. Ir & Coal Trds Rev—Feb. 13, 1903. No. 53699 A.

New Dining and Parlor Café Cars, Baltimore & Ohio R. R. Exterior and interior views, floor plans and description. 1200 w. Ry & Engng Rev—Feb. 21, 1903. No. 53840.

Car Lighting.

Car Lighting. E. G. Fisher. Describes the acetone-acetylene storage system. 2500 w. Ry & Engng Rev—Feb. 14, 1903. No. 53634.

Railway Carriage Lighting by Electricity: J. Stone & Co.'s System. J. H. Dowling. Read before the Dublin Local Soc. of the Inst. of Elec Engrs. Illustrated detailed description. 3000 w. Elec Engr, Lond—Jan 23, 1903. No. 53475 A.

Symposium on Car Lighting. Extracts from papers read before the New England Railroad Club, considering the various systems of lighting cars. 8500 w. Ry Age—Feb. 20, 1903. No. 53807.

The Present Status of the Art of Illumination, with Reference to Train-Lighting (Der Heutige Stand der Beleuchtungswesen mit Berücksichtigung der Beleuchtung der Eisenbahnwagen). Dr. W. Wedding. A general discussion of the technics of artificial lighting, presented before the German Railway Association. 3000 w. Glasers Annalen—Feb. 1, 1903. No. 53730 D.

Car Truck.

The Flexible Car Truck. Charles S. Shallenberger. Discusses the evils of various forms of trucks and methods of remedying them, suggesting the introduction in car truck construction of spring-bearing column guide plates, giving longitudinal flexibility for the absorption of shock. Ill. 2500 w. St. Louis Ry Club—Jan. 9, 1903. No. 53373.

Draft Gear.

The Friction Draft Gear Problem. R. A. Parke. Extracts from a paper read before the New England Ry. Club. Discusses this subject, showing how difficult is the problem. 2200 w. R R Gaz—Feb. 13, 1903. No. 53544.

High Speed.

Prize Announcement (Preisausschreiben). Record of the meeting of the Verein Deutscher Maschinen-Ingenieure for the award of prizes for high speed express steam locomotives for passenger service; with discussion of the awards. 2500 w. Glasers Annalen—Feb. 1, 1903. No. 53731 D.

Locomotive Appliances.

Locomotive Draft and Spark Arrester Appliances. J. E. Muhlfeld. States the advantageous features claimed for this device, discussing criticisms. Ill. 2000 w. Ry Age—Feb. 13 1903. No. 53579.

Locomotives.

Atlantic-Type Locomotive for the Norfolk & Western. Illustrated general description of high-speed engines. 500 w. R R Gaz—Feb. 6, 1903. No. 53425.

Chicago & Alton "Pacific" Locomotive. Illustrated description of engines built for passenger service between Chicago and St. Louis. 900 w. Ry Age—Feb. 20, 1903. No. 53806.

"Decapod" Passenger Locomotive for the Great Eastern Railway. Illustrates and describes an engine of exceptional power possessing features of interest. 1200 w. Engng—Jan. 23, 1903. No. 53453 A.

Midland Railway Three-Cylinder Compound Passenger Locomotives. Two-page engraving and full illustrated description of this new type engine for the heaviest express traffic, with indicator diagrams, and report of trials, experiments, etc. 3300 w. Engng—Feb. 6, 1903. No. 53613 A.

New Freight Locomotive for the "Burlington." Illustrated description of a heavy locomotive of the 2-8-0 type. 300 w. Am Engr & R R Jour—Feb., 1903. No. 53427 C.

Norfolk & Western Atlantic Locomotive. Illustrated detailed description of an engine expected to run at rather high speed. 400 w. Ry Age—Feb. 13, 1903. No. 53578.

Passenger Locomotive—Northern Pacific Railway. Illustration, general dimensions and description of an engine of the 4-6-2 type. 500 w. Am Engr & R R Jour—Feb., 1903. No. 53431 C.

Suburban Locomotive, Great Eastern Railway. Explains the reasons for this enormous locomotive, and gives illustrated detailed description of this machine which is a great departure from normal railway practice in Great Britain. 2000 w. Engr, Lond—Feb. 6, 1903. No. 53618 A.

Ten Wheel Coupled Locomotives in South Africa. Illustration, with brief description of the largest and most powerful engines yet used on so narrow a gauge, 3 ft. 6 in. 600 w. Engr, Lond—Feb. 13, 1903. No. 53698 A.

The Comparison of Locomotives. Lawford H. Fry. An extension of the analysis of the "B D" method to cover compound locomotives. 2000 w. Am Engr & R R Jour—Feb., 1903. No. 53429 C.

Twenty-five Years of Locomotive Development. A brief review of locomotive practice in 1878, and the improvements introduced since that date. 4000 w. Ry Mas Mech—Feb., 1903. No. 53801.

Private Car.

Private Car "Brunswick," Brunswick & Birmingham R. R.. Exterior and interior views, with floor plan and descriptive notes. 700 w. Ry & Engng Rev—Jan. 31, 1903. No. 53392.

Supply Car.

The Railway Supply Car. J. P. Murphy. Discusses the distribution of supplies with a regularly assigned car, and the merits of the system, giving an illustrated description of an arrangement found practicable. Discussion. 10800 w. Pro W Ry Club—Jan. 20, 1903. No. 53568 C.

Wheels.

Cast-Iron Wheels to Meet To-day's Requirements. Papers by F. W. Sargent, Pemberton Smith and W. J. Taylor, with discussion. 11700 w. N Y R R Club—Jan. 16, 1903. No. 53648.

The Chilled Iron Car Wheel. C. V. Slocum. Brief paper on the strength and durability of these wheels and the demands made on them, followed by discussion. 7300 w. Ry Club of Pittsburgh—Nov., 1902. No. 53649 C.

NEW PROJECTS.

Africa.

South African Railways. Editorial review of the new railway work about to be undertaken and the development of the lines already constructed. 1700 w. Engng—Jan. 23, 1903. No. 53455 A.

Ecuador.

Some Features of the Guayaquil and Quito Railway, Ecuador. William D. Beatty. An illustrated article describing the construction of this railway in equatorial regions, the country, labor available, etc. 4000 w. Pro Engrs' Club of Phila—Jan., 1901. No. 53674 D.

Improvements.

L. B. and S. C. Railway Improvements. A descriptive and illustrated account of some of the more important works being carried out on the London, Brighton, and South Coast Railway, viaducts, bridges, etc. 1500 w. Engr, Lond—Jan. 23, 1903. Serial. 1st part. No. 53463 A.

Nicaragua.

The Central Railway of Nicaragua. Emil Mueller. Map with brief description of the new division connecting the previously built railways, thus making a continuous line from Corinto, on the Pacific, to Granada, on Lake Nicaragua. 700 w. Eng News—Feb. 12, 1903. No. 53536.

PERMANENT WAY & FIXTURES.

Grades.

Virtual Grades for Freight Trains. Continued discussion of paper by A. C. Dennis. Plate 1700 w. Pro Am Soc of Civ Engrs—Jan., 1903. No. 53353 E.

Rails.

Notes on Girder Rail Design. Selwyn Grant. A discussion of grooved rails of the ordinary pattern, giving illustrations, and such information as is needed in making a choice. 3000 w. Tram & Ry Wld—Feb. 12, 1903. No. 53687 B.

Road Bed.

The Standard Road Bed of the Swiss Government Railways (Die Oberbau Normalien der Schweizerischen Bundesbahnen). Giving the standard rail sections and also full details of the standard metallic cross ties. 2000 w. Schweiz Bauzeitung—Jan. 31. 1903. No. 53755 B.

Roundhouse.

New Roundhouse of the New York Central at Rensselaer. Illustrates and describes a new passenger engine roundhouse and its attendant facilities. 2400 w. R R Gaz—Feb. 20, 1903. No. 53652.

The New Roundhouse at Rensselaer. Illustrates and describes a roundhouse of the New York Central & Hudson River Railroad, and its equipment. 700 w. Am Engr & R R Jour—Feb., 1903. No. 53428 C.

Shops.

A Modern Car Shop. W. E. Sharp. An illustrated article describing the arrangement considered best suited to give large output at the lowest cost, the operation, etc. Discussion follows. 4000 w. Pro W Ry Club—Jan. 20, 1903. No. 53569 C.

Pocatello Shops of the Oregon Short Line. Illustrates and describes details of this enlarged shop plant in Idaho. 2000 w. Ry & Engng Rev—Feb. 7, 1903. No. 53500.

Railway Shops. R. H. Soule. The first of a series of articles on modern railroad shops and their problems. 1400 w. Am Engr & R R Jour—Feb., 1903. Serial. 1st part. No. 53430 C.

Signals.

An Official Recommendation of Automatic Stops in Connection with Block Signals. Extract from report of the Illinois R. R. & Warehouse Commission in which F. G. Ewald strongly favors automatic brake-setting devices. Ill. 2500 w. Eng News—Feb. 19, 1903. No. 53657.

Development of Railway Signalling in the Last Twenty-five Years. A review of the development in block signalling, and interlockings. Ill. 4500 w. Ry Mas Mech—Feb., 1903. No. 53803.

Telephones in Engine Cabs. Describes the nature and operation of a new safety device for railroads, which has been tested in Germany. 600 w. Sci Am Sup—Feb. 21, 1903. No. 53824.

I. The Miller Automatic Railway Signals. II. Fixed Signals on Line Side v. Signals Carried on Locomotives. III. Editorial. Three articles dealing with the Miller system of automatic railway signalling. 5700 w. Elec Rev, Lond—Feb. 13, 1903. No. 53689 A.

Switches.

The Computation of Turnouts (Die Berechnung von Muttergeleisen). Max Fischl. A discussion of the construction of railway switches and turnouts, including the computation of the curves, and the arrangement of cross ties and fastenings. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 6, 1903. No. 53726 B.

Tracks.

Progress in Track Construction During the Past Quarter of a Century. Considers the subject in detail. 2400 w. Ry Mas Mech—Feb., 1903. No. 53804.

Wear.

Wheel Flange and Rail Wear. H. M. Perry. Discusses the cause and thinks the remedy is in finding a suitable anti-friction side bearing which will allow the truck to swing freely within proper limits and to have sufficient bearing surface to support any load it may be called upon to carry. 700 w. R R Gaz—Feb 6, 1903. No. 53423.

TRAFFIC.

Freight.

Average Lading of Freight Cars and Tons Lading of Freight Trains. J. H. McPartland. Suggestions for the loading of cars that will accomplish a saving. Followed by general discussion. 8800 w. Pro W Ry Club—Jan. 20, 1903. No. 53567 C.

Overland Transport.

American Overland Transport to the Orient. H. Emerson. A discussion of the development of Pacific Coast commerce in connection with the transcontinental railways; considering the pending reversal of the commerce route now existing through the Suez Canal. 4000 w. Engineering Magazine—March, 1903. No. 53791 B.

STREET AND ELECTRIC RAILWAYS

Alternating Current.

Equipment of Railways with Converter Sub-Stations. Alton D. Adams. Reviews the various plans for generating alternating currents for a railway that extends beyond the limits of a single power station, describing the types of equipment, methods, etc. 3000 w. St Ry Rev—Feb. 20, 1903. No. 53821 C.

Berlin.

The Electric Driving of the Great Berlin Street Railway (Der Elektrische Betrieb auf der Grossen Berliner Strassen). A general description of the electrical operation of the surface tramways of Berlin. 4000 w. Elektrotech Zeitschr—Jan. 29, 1903. No. 53769 B.

Bolton.

The Tramway System of Bolton. Map and full illustrated account of this English tramway which has features of construction of interest. Also gives an outline of its history. 7000 w. Tram & Ry Wld—Jan. 15, 1903. No. 53324 B.

Brooklyn.

Improved Power Facilities for the Brooklyn Rapid Transit Company. Plans and interior views of four of the principal sub-stations are given, with descriptive notes. 3000 w. St Ry Jour—Feb. 14, 1903. No. 53580 D.

Cars.

Standard Car in Denver. Brief illustrated description of a car differing materially from that of any other city, but very popular. It is both a combination and semi-convertible car. 3500 w. St Ry Jour—Feb. 7, 1903. No. 53496 D.

Cleveland Trolleys.

The Trolley Situation in Cleveland. A study of the conditions of local short-haul and long-haul electric traffic. 3300 w. R R Gaz—Feb. 6, 1903. No. 53422.

Combined System.

Combined Conduit and Overhead System at Bournemouth. A. N. Connett. An illustrated detailed description of this combined conduit and overhead construction and the arrangement for changing the car from the one to the other. The conduit under one track rail was adopted. 3000 w. Tram & Ry Wld—Jan. 15, 1903. No. 53-323 B.

Conversion

Steam Railroad Converted to Electric System. Illustrates and describes the changes made in the Cincinnati, Georgetown & Portsmouth Railroad. 5000 w. St Ry Jour—Feb. 21, 1903. No. 53826 D.

Electric Locomotive.

A 10,000-Volt High-Speed Electric Locomotive. An illustrated detailed description of the improved design worked out by Herr Reichel. 4000 w. Feilden's Mag—Feb., 1903. No. 53832 B.

Electric Railway Working.

An Arrangement of Power Stations for Operating Steam Railways Electrically. C. J. Spencer. Discusses the applying of electric traction to a steam railroad. Also editorial. 3000 w. Elec Wld & Engr—Feb. 14, 1903. No. 53587.

France.

Electric Road from Fayet to Chamonix. Illustrated detailed description of a road leading to this French village near Mont

Blanc, which is a popular tourist resort. It possesses features of interest. Also describes rolling stock, and notes proposed extensions. 4000 w. St Ry Jour—Feb. 7, 1903. No. 53494 D.

Germany.

The Street Railways of Germany (Die Strassenbahnen Deutschlands). A. Liebmann. A critical analysis of the statistics of German street railways, with diagrams showing the relations of the various elements of operation to the number of passengers. 4000 w. Ill. Zeitschr f Klein u Strassenbahnen—Jan. 16, 1903. No. 53789 D.

Goods Traffic.

Freight and Express on Electric Railways. H. S. Cooper. The first of a series of articles discussing the handling of freight and express by electric roads, the charges, classification, etc. 3500 w. St Ry Jour—Feb. 7, 1903. Serial. 1st part. No. 53495 D.

High Speed.

High Speed Electric Traction (Essais de Traction Electrique à Grande Vitesse). F. Drouin. An illustrated account of the trials of high-speed trains between Berlin and Zossen. Two articles, 2 plates. 5000 w. Génie Civil—Jan. 10, 17, 1903. No. 53713 each D.

Interurban.

Terminal Station and Freight-Handling System for Interurban Electric Railways at Cincinnati, O. Illustrated description of a station for the accommodation of passenger and freight traffic, now under construction. 1500 w. Eng News—Jan. 29, 1903. No. 53311.

Lancaster.

Lancaster Electric Tramways. Illustrated description of the routes completed, the equipment, power, etc., of the Lancaster, England, tramways. 1600 w. Tram & Ry Wld—Feb. 12, 1903. No. 53686 B.

London.

The District Railway and Its Associated Lines. A view of the present situation with map of the lines and drawings of the cars being built for experimental trial. Also an important speech delivered by Mr. Perks to the shareholders. 8000 w. Tram & Ry Wld—Jan. 15, 1903. No. 53325 B.

Overcrowding.

The Overcrowding of Street Cars. Dr. Louis Bell. Discusses some of the causes and what can be done to remedy them. 2000 w. Elec Rev, N Y—Feb., 14, 1903. No. 53581.

Paving.

The Paving of Permanent Ways for Tramways and Light Railways. From the *Railway Engineer*. Gives the laws of England in regard to the requirements, and the kinds of paving used. Discusses the mineral composition of some paving stones, wear, etc. 4500 w. Quarry—Feb. 1, 1903. No. 53605 A.

Returns.

Returns from Electrified Steam Railroads. Editorial discussion of the returns from the lines of the New York, New Haven & Hartford. 1500 w. R R Gaz—Feb. 13, 1903. No. 53547.

South Carolina.

Columbia Electric Street Railway, Light & Power Co., of Columbia, S. C. An illustrated detailed description of the construction, distribution, equipment, and other features. 4000 w. St Ry Rev—Feb. 20, 1903. No. 53818 C.

Trolley.

Railless Electric Trolley System. Enrico Bignami. Illustrated description of system used by Siemens & Halske, of Berlin. 1000 w. Elec Rev, N Y—Jan. 31, 1903. No. 53400.

Trolley Wires.

The Suspension of Trolley Wires (Die Aufhangung des Fahrdrahtes Elektrischer Bahnen). F. Hermann. A discussion of the stresses in overhead trolley wires, taking into account the weight of the wire and the effect of temperature changes. 3000 w. Ill Zeitschr f Klein u Strassenbahnen —Feb. 1, 1903. No. 53790 D.

Valtelline.

The Operation of the Valtelline Railway by High Tension Polyphase Currents (Der Betrieb der Valtellina-Bahn mit Hochgespanntem Drehstrom). E. Cserhati & K. von Kando. A very complete account of the Valtelline electric railway, in which the Ganz polyphase system is used. Serial, Part I. 3000 w. Zeitschr d Ver Deutschr Ing—Feb. 7, 1903. No. 53710 D.

Valtellina High-Tension Three-Phase Railway. An interesting account of this line which is exciting much interest, as it is testing the application of electricity to the conditions of steam roads, and may lead to the conversion to electric traction of all roads of Northern Italy. Ill. 3000 w. Engr, Lond—Jan. 30, 1903. Serial. 1st part. No. 53561 A.

Vienna.

The Metropolitan Railway of Vienna (Le Chemin de Fer Métropolitain de Vienne). René Philippe. An illustrated description of the overhead, surface, and underground municipal railway of Vienna. Two articles, 1 plate. 5000 w. Génie Civil —Jan. 31, Feb. 7, 1903. No. 53717 each D.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
American Telephone Journal. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* Philadelphia.
Electrochemist & Metallurgist. *m.* London.

Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Feilden's Magazine. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Straussenbahnen. *s-m.* Berlin.
Indian and Eastern Engineer. *m.* Calcutta.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton. U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* New York.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Electrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Compressed Air.

Compressed Air Information, or a Cyclopedia Containing Practical Papers on the Production, Transmission and Use of Compressed Air. Edited by W. L. Saunders, M. Am. Soc. C. E. Size, 8¾ by 6½ in.; pp. 1175; illustrations, 498. Price, $5. New York: "Compressed Air."

The articles composing this book are reprints of the principal papers, editorials and notes which were published in *Compressed Air* during the first five years of its existence. They cover a wide range of subjects and are grouped under the three main headings of Production, Transmission and Use, the latter section occupying more than two-thirds of the volume. There are many articles on air compressors and methods of compressing air, including the hydraulic system of air compression, but the most extensive and probably the most interesting part of the book is that devoted to the multitudinous applications of compressed air, including pneumatic tools, painting, the sand blast, pneumatic locks for canals, car traction and hoisting, to mention only a few. There is a list of United States patents relating to compressed air and its applications, and an index, and altogether this volume is, as its title well indicates, a compressed-air cyclopedia.

Drawing.

A Manual of Drawing. By C. E. Coolidge, Assistant Professor of Machine Design, Sibley College, Cornell University. Size, 9 by 6 in.; pp. IV., 178; figures, 43. Price (paper) $1. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The system that has been evolved and embodied in this book is intended to be the average of the drafting room systems which are in use in the United States at the present day. Part I of the manual is devoted to drawing materials and instruments, which are described in considerable detail. In part II, commercial mechanical drawing is taken up, the different types of drawings are discussed and the proper methods of executing them are shown. Special attention is given to "dimensions," and other practical details are well treated. Altogether, the book is a most useful one for students and will not be out of place in the professional drafting room.

Dynamo Design.

Design of Dynamos. By Silvanus P. Thompson, D. Sc., F. R. S. Size, 9¼ by 6 in.; pp. VI, 253; illustrations, 92; plates, 8. Price, 12s. 6d. ($3.50). New York: Spon & Chamberlain. London: E. & F. N. Spon, Ltd.

In his well-known treatise on Dynamo-Electric Machines, of which the seventh edition is soon to be issued, the author has treated the whole subject broadly, historically, theoretically and practically. The present shorter work is intended principally for students and for engineers who are acquainted with the theory of electricity and magnetism, but who have had no practical experience in the design of electric machinery, and its immediate end and aim, therefore, is to give such persons a working insight into the procedure of dynamo design as carried out in recent years for the construction of continuous-current dynamos of modern type. There are chapters on dynamo design as an art, magnetic calculations as applied to dynamo design; copper calculations and coil windings; insulating materials; armature winding schemes; estimation of losses, heating and pressure drop; the design of continuous-current dynamos; and examples of dynamo design. An appendix contains wire-gauge tables and schedules for the design of continuous-current dynamos, and there are plates with curves of magnetic data and designs of dynamos. The book is well made and printed, and an index completes a very useful and practical work.

Erie Railway.

Between the Ocean and the Lakes. The Story of Erie. By Edward Harold Mott. Size, 10 by 12 in.; pp. XII, 524. Price, $7.00 (30 shillings). New York: John S. Collins.

The history of the first railroad built in the United States for the avowed purpose of beginning the opening up of the great West would in itself be a work of essential importance in connection with the story of the development of the nation, but when the history is also that of the origin and development of the whole gigantic system of railway speculation and stock manipulation so essentially a portion of finance and investment in all parts of the world, it becomes doubly important. The story of

Erie is indirectly the history of the railroads of the United States, it includes striking and exciting incidents without precedent, it involves personal sacrifices and efforts of men prominent socially and financially, it evolves many of the ideas in the modern science of railroading, it is as startling and dramatic as any incidents which enliven the pages of fiction. It is not alone the history of a railroad, it is a history of men and measures and methods which for two generations were powerful in the social, financial, and commercial affairs of the United States and Europe. The narrative is not without its dark side, and in its pages are revealed details of dishonesty and crime which carry their lessons with them. In this difficult portion of the work, as in the entire volume, Mr. Mott has done his work well, and the laborious and tedious study of reports, newspapers, and old publications which he has conducted has preserved from oblivion facts of vital importance to the modern student of history, to the man who realizes that the true history of a people is found, not only in the records of its legislative bodies and on its battle fields, but also in the daily life of its people and in the conduct of its great industrial enterprises. The book is handsomely printed and copiously illustrated, and includes many portraits and fac-simile reproductions of documents otherwise most difficult of access.

Kinematics.

Kinematics of Machines: An Elementary Text-Book. By R. J. Durley, B. Sc., Ma. E. Size 9¼ by 6 in.; pp. VIII, 379; figures, 230. Price, $4. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

This work is intended as an introduction to the study of the dynamical and other problems occurring in connection with the theory of machines, and it is based on the author's lectures to students of engineering at McGill University, where he is professor of mechanical engineering. The book deals only with the kinematics of machines, and after an introduction, there are chapters on position, velocity and acceleration; plane mechanism containing only turning pairs; slider-crank chains; determination of velocity and acceleration in plane mechanism; alterations of mechanisms, and closure; constraint and velocity ratio in higher pairing involving plane motion; wheel-trains and mechanisms containing them, and cams; ratchet mechanisms and escapements; mechanisms involving non-rigid links; chains involving screw motion; spheric motion; and kinematic classification of mechanisms. There are graphical and analytical solutions of the various problems encountered, and in the majority of cases numerical examples have been worked out in order to indicate as clearly as possible the practical bearing and the scope of the methods employed. Besides being an excellent manual for engineering students, which is its primary purpose, this book will be of value and interest to all who are concerned with the design and construction of machinery.

Locomotives.

Locomotives: Simple, Compound and Electric. By H. C. Reagan. Fourth edition. Size, 7½ by 5 in.; pp. XIII, 578; illustrations, 303. Price, $2.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Originally called "Locomotive Mechanism and Engineering," this book has grown with the times and enlarged its scope. Its author, a practical engineer, has written a practical treatise, and carefully describes the manner in which the locomotive is handled while in service. The illustrations go into great detail and are fully explained in the text, so that the construction and operation of the various parts of the locomotive can be clearly understood. To impress this understanding firmly on the mind, questions are asked and answered in a way which will be of most benefit to the locomotive engineer. The present fourth edition of this work, besides devoting considerable attention to the electric locomotive and its details, describes the latest improvements in locomotive practice, including the newest types of compound and single-expansion locomotives, fire-boxes and boilers. The subjects of liquid fuel and oil-burning engines are carefully considered, as are also piston-valve engines, track-sanding apparatus, valve-motion for compound locomotives, metallic packing, air pumps and various other matters. The book well fulfills its purpose of putting the reader in touch with the very latest and highest types of locomotive and their details.

BOOKS ANNOUNCED.

Small Yacht Construction and Rigging. By Linton Hope. Price, $3. New York: Forest and Stream Publishing Co.

Electricity as Applied to Mining. By Arnold Lupton, G. D. Aspinall Parr and Herbert Perkin. Price, $3.50, (10s. 6d.). New York: D. Van Nostrand Company. London: Crosby, Lockwood and Son.

Engineering for Land Drainage. By Charles G. Elliott, C. E. Price, $1.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The Sea Coast: (1) Destruction, (2) Littoral Drift, (3) Protection. By W. H. Wheeler. Price, 10s. 6d. ($4.50). London, New York and Bombay: Longmans, Green, and Co.

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THE HARMONIZING OF ORGANIZED LABOR WITH ORGANIZED CAPITAL.

By M. Cokely.

There is no more vital need today than that of applying to the labor question the same enlightened common sense which has lately revolutionized machine-shop equipment and practice. Mr. Cokely's article is earnestly commended as expressing, clearly and concisely, the spirit and method which must direct the change—which by their spread will cause the change. It is a striking statement of the concept underlying the system described in these pages by Mr. Carpenter last month. No shop is too small and no works too large for its full application.—THE EDITORS.

ONE of the most important problems under public consideration at this time is the prevention of what is considered a threatened conflict between labor and capital. In providing a remedy for any trouble it is necessary to know the causes. In this particular case the cause is deep-seated and one that, strange to say, it would be fatal to remove—because it is a virtue as well as a source of trouble. Ambition is the mischief maker. The ambition of the workman under the ever increasing light of civilization is to better his condition. With increasing enlightenment he becomes less satisfied with his present position, and as the same light by which he sees the undesirable features of his condition shows him the means by which he can improve it, his animal nature asserts itself and he makes use of those means.

The same is true of his employer—ambition is what makes an employer of him, and in both cases gratification merely acts as a stimulus to a greater and an increasing ambition. Like the sublime and the ridiculous, there is but a single step between honorable ambition and avarice, and the danger arises when, blinded with greed, both parties are driven in opposite directions on the same road with the inevitable collision as a result. Notwithstanding this, I claim that this very ambition is a sublime virtue when properly controlled and directed, and is as much a necessity to the perfection and development of the human race as any other influence that we know of.

The ambitions of men vary according to their nature and position in life. With the majority it is wealth, fame, and glory, while a small sincere minority are led along spiritual lines by what we might term a negative ambition and exercise a necessary restraining influence on the majority. That with which we have to deal in this article, however, is wealth—the desire for money and all the comforts and luxuries which it is supposed to supply. That kind of ambition which we find planted in the human breast is as necessary to the well-being and perpetuity of humanity as the sunshine is to the vegetable kingdom. Without it all would be chaos; we would stagnate and finally cease to exist. We are on earth for something more than a mere existence —we are here to discover the secrets of nature, develop her resources, and in doing so work out our own destiny and, if possible, lighten the burdens of all humanity. This can be accomplished only under the stimulating influence of the desire for worldly possessions. For that reason I consider ambition, even of that kind, a divine attribute and not in conflict with divine teaching. There is nothing harmful or immoral in the mere pursuit or possession of wealth; it is only the methods by which it is acquired and the uses to which it is applied that are open to question.

On this theory, then, both the employer and the employed are justified in securing even from the same source of supply all the wealth they can possibly obtain consistent with the rights of all concerned. This brings up the question of their respective rights in the pursuit of wealth and the realization of their ambition. That of the workmen to organize for mutual protection and advancement is undoubted, and their right to leave their employer's service when dissatisfied with existing conditions should be unquestioned—but not under an official order from their organization; this, I think, will mark the limit of any sustained legal ruling in the United States. Once out of their employer's service, however, no matter what their grievance may have been, they have no legal or moral right to interfere with or injure his business in any way either directly or indirectly. Local conditions being considered, they have a right to at least the average wages of their trade throughout the country, and at all times the undoubted right to a sufficient wage when honestly earned and judiciously expended to support their families in conformity with national standards of living. On the other hand, the employer should have the right to hire or discharge anyone he may consider necessary to the success of his business—as many or as few of any particular trade or calling as he in his judgment requires to insure profitable returns from his investment. This right of the employer, with that of the employee to sell his skill and labor in any market and at any price and to terminate his service at any time, are sacred and fundamental and as necessary to the welfare of the people as the freedom of speech or the liberty of the press. No abridgment of these privileges should be tolerated, excepting through private contract and mutual consent. In no charter issued by any state is it stipulated that the company so chartered shall employ any particular man or body of men, or pay any particular rate of wages; and when they have satisfied all legal and moneyed conditions necessary to secure the privilege of establishing and operating their business, they have done all that can be expected of them, and should not be compelled to employ anyone objectionable to them, as every employer of labor knows that all help forced on him is practically worse than no help at all.

This theory is contrary to the oft-repeated and humane sentiment that labor is entitled to a chance to earn a living. True—labor is entitled to such a chance; but no one—not even the State—has a right to say to any employer that he must give any particular labor a chance to make a living in his employ, particularly when the employment of such labor would be detrimental to his interests. Better by far that all employers of labor should be taxed for the support of those who cannot get a chance to make a living, if such there be, than to interfere with the management of their private business.

It seems like a natural law when viewed from a moral standpoint that responsibilities are in direct proportion to privileges. The former are morally inseparable from the exercise of the latter, and when we claim for the employers the rights and privileges mentioned in the foregoing, it is with the understanding that they should realize this incontrovertible fact, that there is in the population a preponderant element of rational human beings dependent on them, and them alone, for all that makes life worth the living. Stop all employment of labor and we will have barbarism; employ all labor and we will have civilization. It is through the free exchange of a unit of mental or physical effort for its equivalent in wealth that the human race is evolving from barbarism to civilization. It is necessary, then, that employers should realize this truth and take a broad view of the importance of their position, because with them more than any other class rests the responsibility for their country's commercial and industrial success and the welfare of all its inhabitants.

How are they to fulfil this obligation under present conditions? By the formation of a universal organization of employers based on an unselfish attitude toward their workmen, and with the greatest possible latitude for the exercise of individual action by its members. Foremost among the objects of such an association should be not only to protect its members from the unjust demands of their workmen, but to insure justice to the workmen at the hands of its members. It is incumbent on the employers to set the example in this respect. We know that it frequently happens that although the sentiments of the most heavily interested employers toward their workmen are of the most kindly nature, there will arise misunderstandings, discontent, and sometimes open conflict. This occurs largely where the magnitude of a business is such that the employer cannot keep in touch with the feelings of his workmen and must depend on subordinate officials for the maintenance of cordial relations. It is under circumstances of this kind that the perversity of human nature clothed in that transparent cloak of gentility will sometimes manifest itself, resulting in losses the extent of which is seldom realized. While the burdens of large employers of labor are so great as to render their personal attention to details a physical impossibility, they are nevertheless responsible for the actions of their subordinates.

I believe that the nature of the average workman in America, and perhaps elsewhere, is such that when persistently approached in a conciliatory manner he can be reasoned with sufficiently to see and appreciate the fact that his interests are identical with those of his employer. In order to accomplish this desirable result it is imperative that his employer should voluntarily concede whatever he is justly entitled to, without waiting for the command of organized labor or the force of public opinion. If that had been done to a greater extent in the past it is possible that we might hear less of the arbitrary demands of organized labor now. Nevertheless it is a policy which will always be in order, and when backed by the power of united capital, which organized labor has made an absolute necessity, its influence for good will be felt throughout the whole industrial field. With united capital —that is, an employers' organization—organized labor will be more inclined to listen to reason. Courts will take courage and cease to shuffle with property rights, and will forever establish the fact that when an employer has satisfied all legal requirements he should be protected in his right to manage his business according to his own best judgment and to market his product without fear of molestation. The effect of such ruling will in all probability drive labor into politics as a distinctive element. This emergency can be left to the consideration of our statesmen.

Labor, when organized to the extent to which it now aims, will hardly show sufficient prudence and toleration to command the confidence of business interests. For that reason organized capital sufficiently generous and wise to recognize the just rights of labor, and strong enough to resist its arrogance, is a necessity. Since we must have organization, the better both sides are equipped in that respect the less liability of strife, owing to fear of each other. Prudence is the child of fear. This principle is well demonstrated in international relations and it will hold equally well between smaller bodies, even down to the individual. We know that however well disposed labor leaders are toward law and order during strikes, they are incapable of preventing or suppressing lawlessness. In fact, if they were and did, they would not long remain leaders. The best evidence of this truth is the fact that we hear of no cases of punishment for this crime by the unions. For that reason, and in order to support those of its leaders who are kindly and fairly disposed, capital must present a solid front to organized labor. This is necessary in order to set them to thinking—thinking of the whole industrial situation instead of a portion of it. And while in that desirable frame of mind they may, instead of deciding to try conclusions with capital on that grand scale of which some of their misguided friends so flippantly talk, awake to this one wholesome truth, that under circumstances of that kind it is in the power of two or three capitalists to send a sufficient number of the financial institutions of the country tumbling in ruins to bring labor to its knees in a very few weeks. It would be well for employers to realize that also, in order to inspire them with sufficient courage to maintain their rights under the blessings of continued prosperity for which they so loudly called, rather than be talking of an industrial depression to help them resist what they consider the unjust demands of labor. While measures of this kind would be heroic they would probably be justified, notwithstanding the sacrifice, because we know that there are no great and lasting benefits without great sacrifices. The object, then, is to bring organized labor to its senses before that climax is reached—to get both sides in that conciliatory frame of mind wherein they can consider each other's contentions with a just appreciation of the power and resources which could be utilized in the event of disagreement and conflict. Under a full realization of what this would mean, they would be likely to find some means by which differences could be amicably adjusted.

The most common method now in use is voluntary arbitration—compulsory being out of the question in America. That this method has given good results in most cases cannot be denied. It has settled disputes between labor and capital, thus giving motion to the wheels of commerce and industry, and anything that will accomplish that is commendable. But notwithstanding this, arbitration is, in my opinion, but a mere temporary expedient and does not go to the root of the trouble. What it produces is practically a forced settlement by the intervention of a third party. What is wanted is some means by which capital and labor can control their passions and prejudices sufficiently to settle their disputes without outside interference. This may call for an extraordinary control of human nature. Granted that it does. Nevertheless when we reflect on the fact that practically all that is best and noblest in this world is the product of voluntary human restraint, and that due to the teachings of individuals at one period or another of the world's history, we can see no reason why we cannot hope for a little more of mutual magnanimity between the two most potent forces controlling human happiness. To arbitrate practically means to compromise, and he whose demands are the most frequent is the greatest gainer. Rarely, if ever, will demands meet with complete refusal in a court of arbitration. For this reason it is singular that labor has been so slow in recognizing its advantage to their interest.

The settlement of wage questions by arbitration or through labor-union leaders would in time be productive of class distinction, because it destroys the opportunity for those close personal relations between the employer and the workman which the individual adjustment of remuneration makes necessary. As a result, I believe the tendency will be for the individual workman to look to his union and organized labor generally for all that he expects from his employer, no matter how well disposed the latter may feel toward him. This is just what organized capital should endeavor to prevent, because it is, fundamentally, a step in the wrong direction. It is reducing the all-important unit—the individual—to a mere cipher. It is also placing his destiny under the influence of a pernicious system of restriction. At the very outset of his career he meets apprenticeship and other rules that deprive him of rights guaranteed by the constitutional law of his country—the choice of such trade or profession as may be indicated by his natural inclinations, and the privilege of producing according to his ambition and physical endurance. Such a policy is contrary to the best interests of all concerned. Idleness, forced or voluntary, during working hours is subversive of morals and manliness. The men whose names will live the longest are those who in life work the hardest. It does not require prophetic vision to discern that the trend of industrial evolution is in the direction of an intensity of effort—harder work in proportion to shorter hours; and when effort is up to the limit of human endurance, facilities, the product of the brain, will come to its aid. Shorter working hours with two or more shifts as local conditions require is what we are coming to. This policy will give far better results to the workman in the long run than restriction, but it is hard to make him see it and his employer has not the courage or foresight to prove it to him. If capital can be brought to see that this is a true principle of industrial economy and prepare for its advent, much saving will be effected and friction avoided.

But above and beyond all other principles should be the care and encouragement of the individual workman. His freedom of thought, action, and ambition along industrial lines should be the earnest solicitude of all employers of labor. By kind and generous treatment particularly in youth, he should be made to see that his interest is with his employer. His ambition should be gratified, and if latent, aroused. The fact that a workman does not personally force recognition of his merits is not sufficient evidence that he does not possess the necessary qualifications for an ambitious workman and faithful friend of his employer. That fertility of soil is not always reflected by surface indications is as true in human nature as it is in agriculture. The thing to do is to cultivate it by sowing the seed of ambition right down to that point where the youth in all his simplicity of mind and ignorance of his future steps upon the industrial field. Show him by the justice of your treatment and the strength of your resources that it is in your power to reward and protect him. You may not harvest all you cultivate, but you will enough to leaven the mass. The avidity with which the employees of the United States Steel Co. took up the stock set aside for them is an indication of the direction in which to move. Some day those large industrial combinations will add the "committee for the encouragement of the willing worker," and all that the title suggests, to their systems of committee management. They will find it a very important and profitable department.

In looking over the whole industrial situation there does not seem to be any cause for serious alarm among men of cool judgment, clear vision, with a just appreciation of their rights, and the courage of their convictions.

THE DEVELOPMENT AND USE OF THE SMALL ELECTRIC MOTOR.

By Fred. M. Kimball.

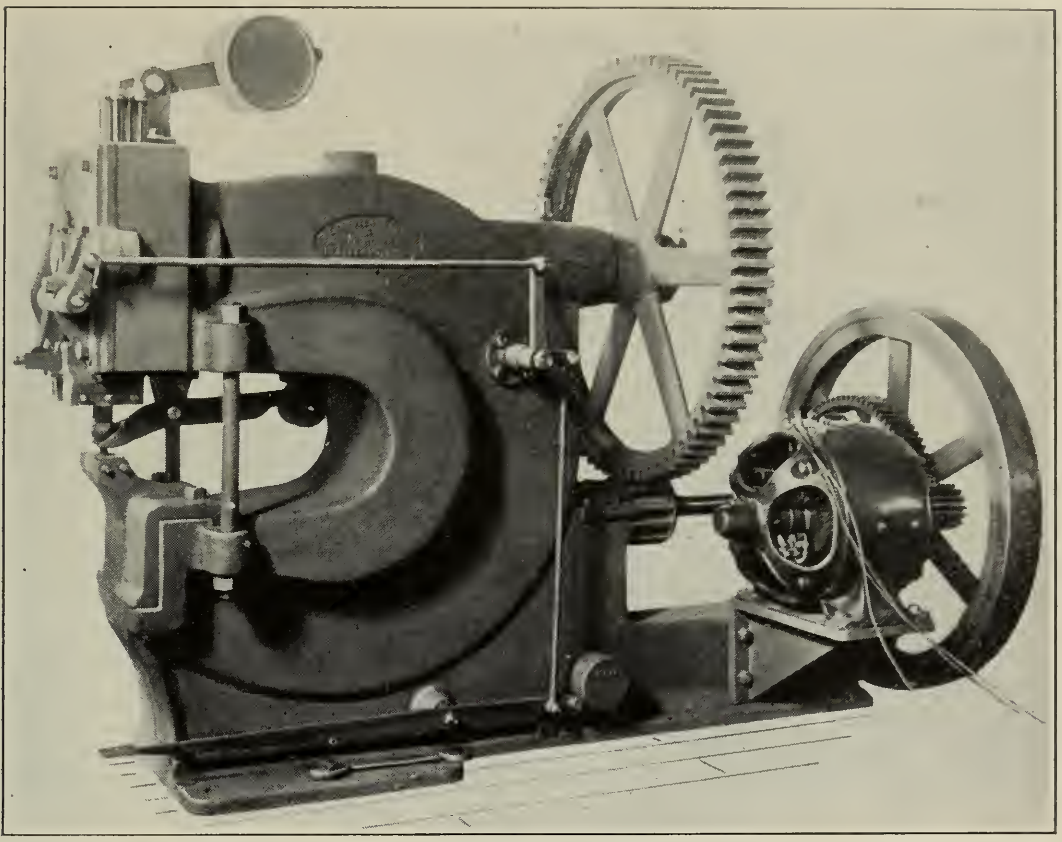
II.—THE ELECTRIC MOTOR IN THE MACHINE SHOP.

In the series of articles which began in our April number, and of which this is the second, Mr. Kimball addresses himself to the questions which meet the factory owner or manager—"where and how will I economize by using electric drive, what points must I consider and what methods must I follow in installing motors, and what effects on shop practice and organization will follow?" While primarily related to the machine shop, the treatment will have wide application to all manufacturing industries. The June number will deal with "The Choice of Electric Motors."—The Editors.

MECHANICAL engineers have long been aware of the great losses in the productive capacity of shops and tools through the wasteful distribution of power by shafting and belting, and also through the impossibility, by any speed-changing devices which were available, of keeping the machines up to their maximum production over a wide range of operation and on different classes of material. Hence, when once the utility and fitness of the electric motor as a means of distributing power had become apparent, and manufacturers had seen its possibilities in the way of speed variation, flexibility of application, economy of operation, and cheapness of maintenance, they were not slow to take up its use, tentatively, at least.

Printers, in particular, were eager to adopt the new method of operating their presses, and it is to the owners of large printing establishments that the opportunity of demonstrating the utility of the electric motor, and thus making it attractive to other users of machinery, is very largely due.

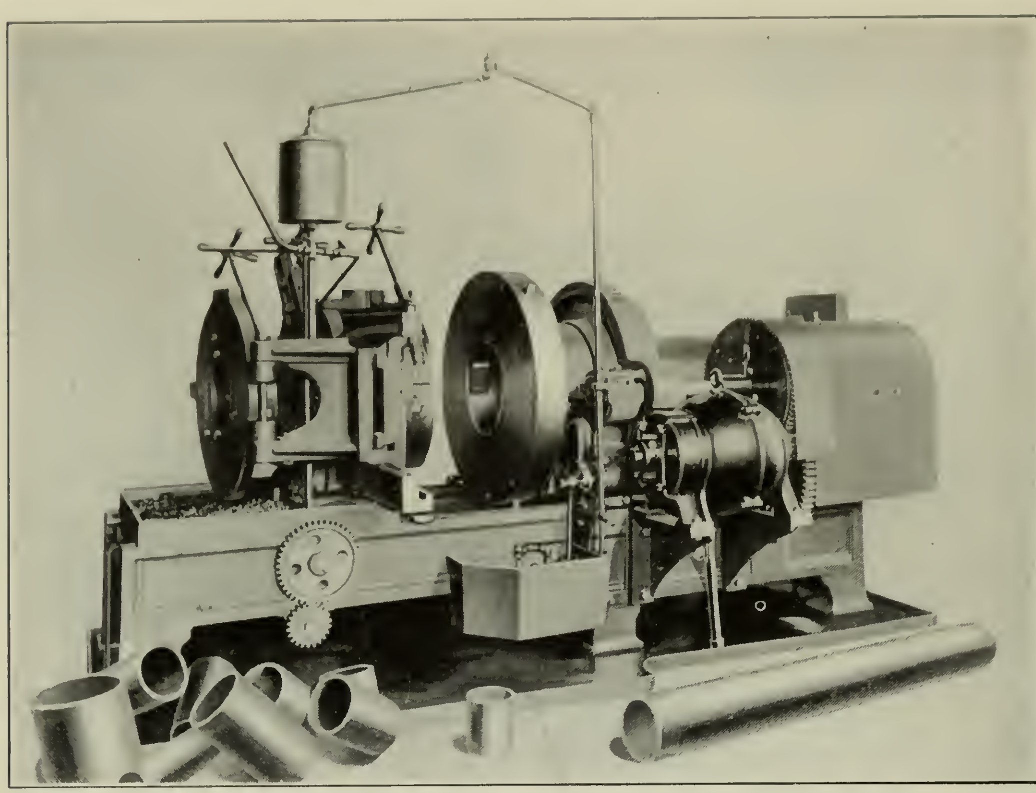
For a number of years after the first practically operative motors were installed, little was accomplished in the way of effective speed regulation—the use of the electric motor being principally confined to driving line shafts or the supplying of power to small manufacturers from central stations. Ere long, however, the possibilities of eliminating much of the head shafting, main shafting, and heavy belts in large manufacturing establishments, by means of sectional power distribution from electric motors, became so apparent that a considerable number of manufacturing companies were induced to put in electric



MOTOR-DRIVEN PUNCH.
Cleveland Punch & Shear Works Company; General Electric Motor.

generating plants and to distribute motive power therefrom to groups of machines located on the various floors and throughout the various buildings of the works.

The general results from all these undertakings were of the most satisfactory character and the demand for motors and accessories increased from year to year at an astonishing rate. Four or five years ago the demands for products of American manufacture began to expand to such an extent that it became necessary for factory managers to make a special and more vigorous study than ever before of the problem as to how they might increase the product of their various shops or factories without adding new machinery, taking the time to re-arrange their buildings, or building new ones. About the same time, experiments previously undertaken in producing better steel from which cutting tools might be made, began to bear fruit, and it was found, a little later, that by the use of the Taylor-White and other similar processes, tool steel might be manufactured which would allow a cut and feed of such magnitude as to increase very largely the amount of metal which could be removed from any work being machined during a given time. This meant the possibility of enormous



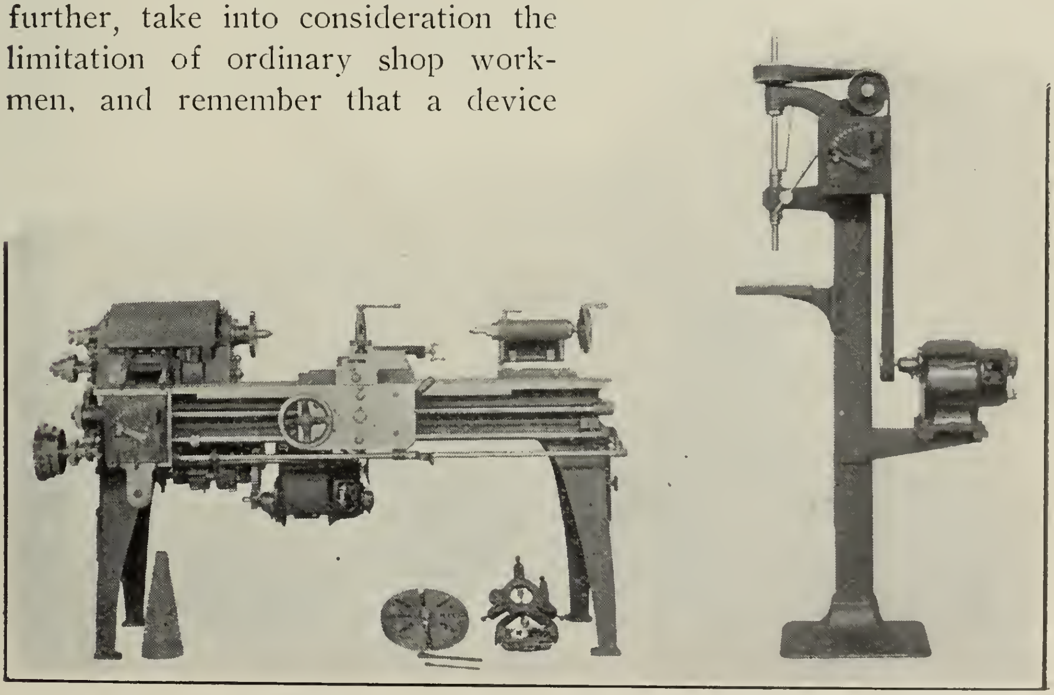
SAUNDERS PIPE-CUTTING AND THREADING MACHINE GEARED TO SPRAGUE ELECTRIC COMPANY'S MOTOR.

savings through increased production from the same floor space and tools and under practically no greater fixed charges. Concurrent with the advance in this direction, came an investigation of the possibility of better speed control for machine tools, whereby the cutting speeds might always be kept up to the maximum through an exceedingly wide range of work and the cutting tools pushed to the highest possible duty. No system of belts or other mechanical power transmission available has alone been found adequate to meet the possibilities in this direction which may be realized through the use of variable-speed motors.

There is a very wide difference of opinion between the manufacturers of machine tools, the proprietors of shops, and the workmen whom one interviews, as to how great a range of speed is really necessary with a given tool, within how fine increments of speed variation it is necessary to bring the speed control, and whether all of the control should be mechanical, all of the control electrical, or a part electrical and a part mechanical. On the one hand, we find some authorities asserting that a comparatively small range of speed control in the motor driving any given machine is all that is necessary; these people feel that the coarser steps, at least, in speed variation may better be accomplished with change gears, or their equivalents. On the other hand, extremists, especially among some motor builders, maintain with great tenacity that the range should be wide and all produced in the motor itself. Good arguments are advanced to maintain the position taken by the adherents of either system.

Consulting engineers, owners of shops, and manufacturers of motors also differ in regard to the degree to which the subdivision of driving should be carried in the equipment of the machinery in any manufacturing establishment with motors. On the one hand, some engineers and manufacturers advocate the equipment of every machine tool with a separate motor, while others advocate the use of a few motors, of comparatively large size, each driving a moderately long distributing shaft which may supply power to the whole floor or a part of the floor. Here, too, there are good arguments to be advanced in support of either position, but undoubtedly the best practice will ultimately be found to lie midway between the extremes.

The art of motor design and construction has progressed to that point today when, from a purely technical standpoint, almost any problem in motor application may be readily solved and a suitable motor designed and built, which will produce the required results. But as engineers in the broadest and latter-day sense, we must all consider the commercial side; and we must, further, take into consideration the limitation of ordinary shop workmen, and remember that a device

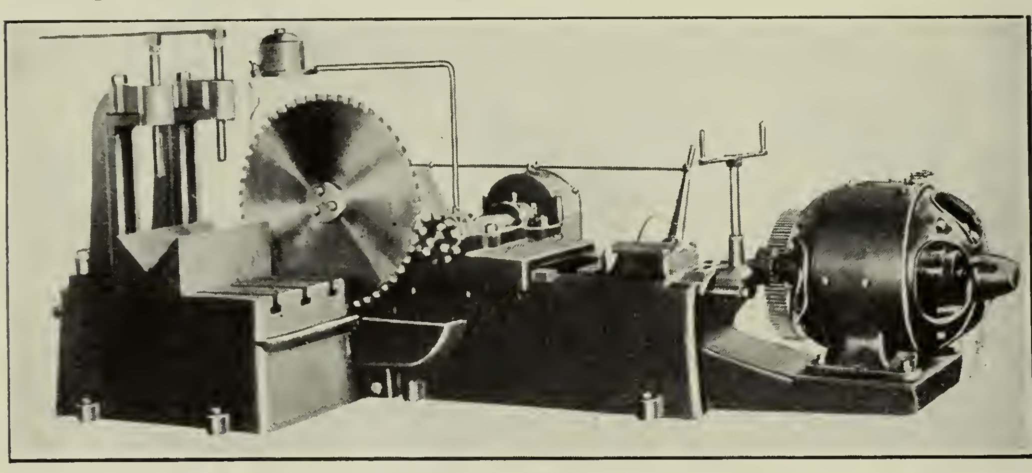


16-INCH PRENTICE LATHE DRIVEN BY ¾-HORSE-POWER MOTOR, AND SINGLE-SPINDLE DRILL DRIVEN BY ¼-HORSE-POWER MOTOR.
An interesting example of individual drive by very small motors. General Electric Co.

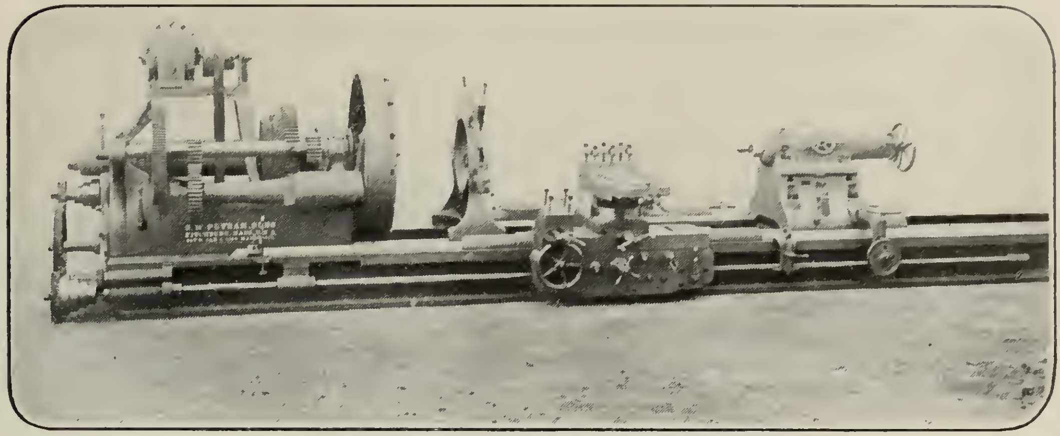
may lose the major portion of its utility—no matter how perfectly designed or excellently built—if it is not handled as it was made to be handled, and if good judgment is not used in its operation. It seems, therefore, at the outset, that one leading feature of any system of electric driving which we may put into a machine shop or factory must, as a *sine qua non,* be its comparative simplicity in construction and operation, and that it shall not necessitate the exercise of a greater degree of knowledge and manipulative ability on the part of the user than he is required to exercise in turning out the work or performing the operation for which the tool or machine as a whole is designed. In other words, we must remember that, if the workmen who are using this apparatus possessed the knowledge and qualifications to enable them to handle it as intelligently as those who designed it, they would undoubtedly be filling other and more advanced positions.

Repeated experiments, carried on at different times and in different manufacturing establishments, by competent investigators, have conclusively shown that the efficiency of power distribution in general rarely rises above 65 per cent., and often does not reach over 30 per cent.; that is to say, in the case of a factory receiving its motive power from an engine, the amount of power wasted in belting, shafting, mules, counters, gears, etc., ranges from 35 per cent. to 70 per cent. of the capacity of the engine.

It has been estimated by very careful engineers, that owing to this waste of power and lack of proper speed control, and outside of factories where special work only is done and special machines are provided for doing it, the product turned out averages only 15 per cent. to 20 per cent. of what might be turned out under the most advan-



METAL-SAWING MACHINE DRIVEN BY 5-HORSE-POWER 250-VOLT SHUNT-WOUND MOTOR.
Railway Appliances Company and General Electric Company.



ELECTRIC-DRIVEN ENGINE LATHE.
Putnam Machine Company's standard lathe; Westinghouse 7½-horse-power alternating-current motor.

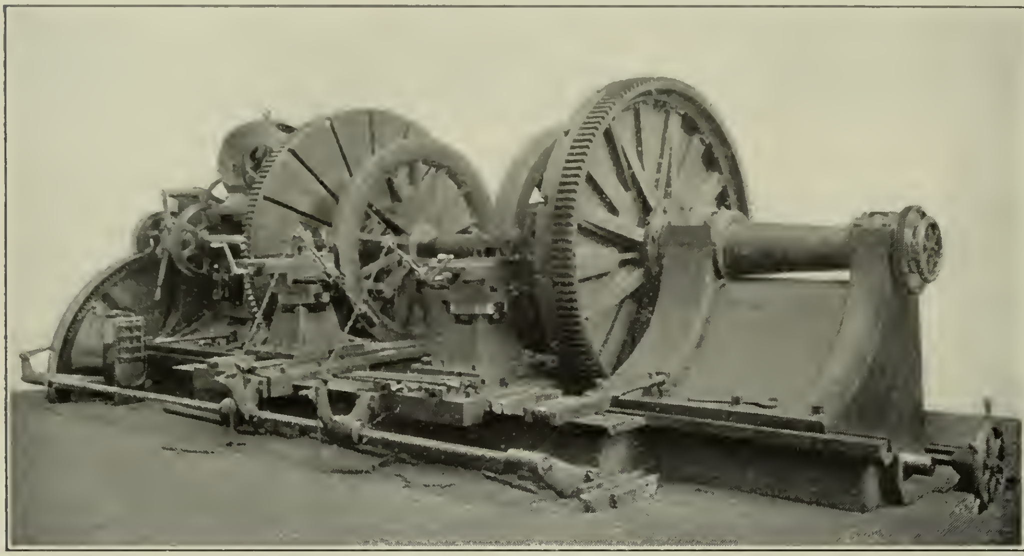
tageous methods of operation. These statements may be somewhat radical, but there seems to be but small doubt that not over 50 per cent. or 60 per cent. of the work is turned out on the average in the general run of such establishments, which might be turned out were they operated under the best conditions commercially attainable.

As an illustration of the loss of productive capacity in a machine tool carrying cutting edges, through the inability of the operator to regulate easily and maintain closely proper cutting speeds at any fixed rate, let us examine an ordinary engine lathe and endeavor to determine what proportion of the time such a machine may be operated at theoretically proper speed when driven in the ordinary way by belts and pulleys and operating on the variety of work which may come to it in an all-round shop.

Let us suppose that there are two equal cones of four steps each, the ratio of extreme speeds being as 40 is to 250; it will not be necessary for us to consider the back gears nor the possibility of doing any work which might necessitate their use, for they but extend the range of obtainable speeds and have little to do with the smallness of incremental speed changes possible. If these cones were not stepped at all but were simple truncated cones of revolution, there might be obtained, theoretically and by careful shifting of the driving belt, two hundred and nine intermediate, integral speeds from the lowest to highest, or two hundred and eleven speeds in all, each varying from the one above or below by one complete revolution of the live spindle.

Let us further suppose that, beginning with the lowest step, a series of changes be chosen as representing the theoretically desirable standard speeds such that each shall vary from that above or below by not more than 2½ per cent. either way; that is, we divide the total possible number of integral speeds into such a number of working speeds that each differs from the other by not more than 5 per cent.

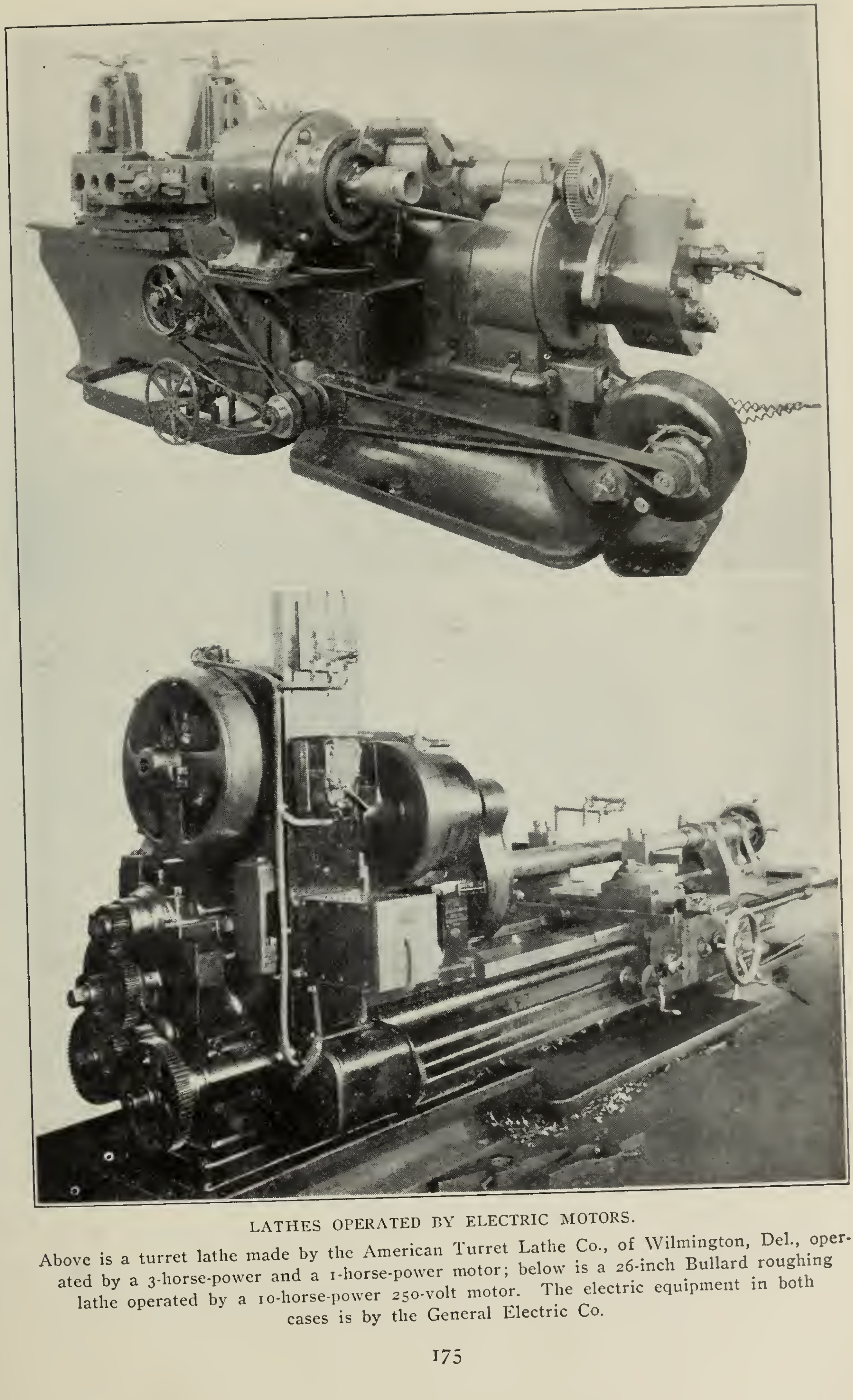
Assuming that the variation of 2½ per cent. either fast or slow will make no appreciable difference in the life of the cutting edge, or the product of the tool, and that such increments fulfill all reasonable commercial requirements of the most finical advocates of minute speed control—then under these conditions, it would be desirable to



15-HORSE-POWER CROCKER-WHEELER MOTOR DRIVING AN 84-INCH NILES DRIVING-WHEEL LATHE, L. S. & M. S. RAILWAY SHOPS, COLLINWOOD, OHIO.

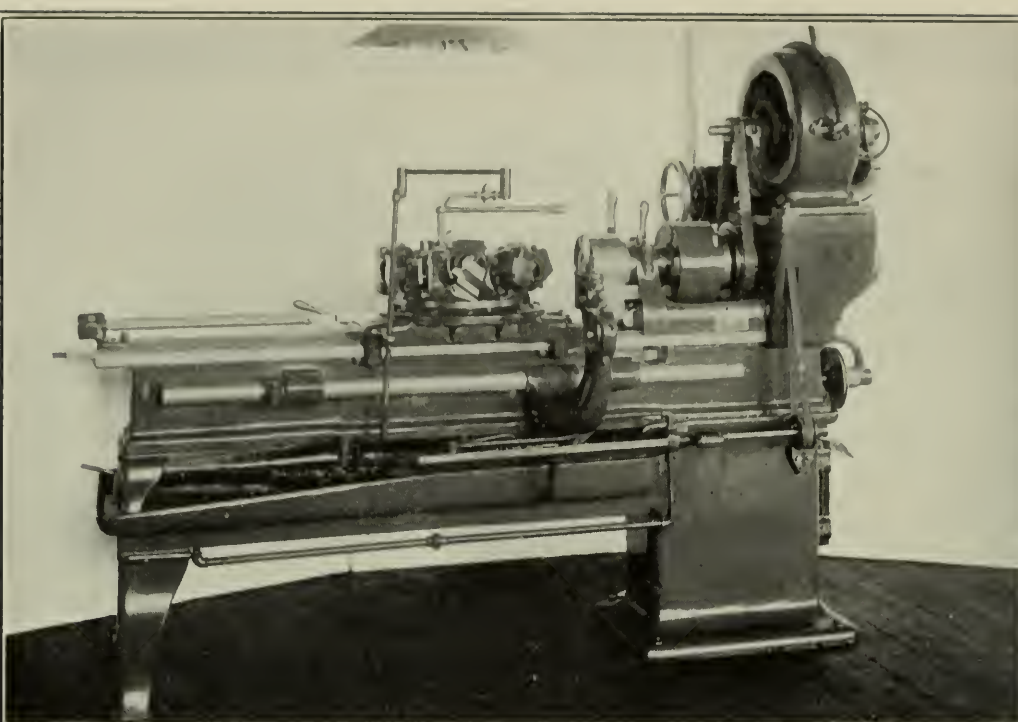
have a total of forty-two steps in our cones to enable us to obtain the best results and highest production.

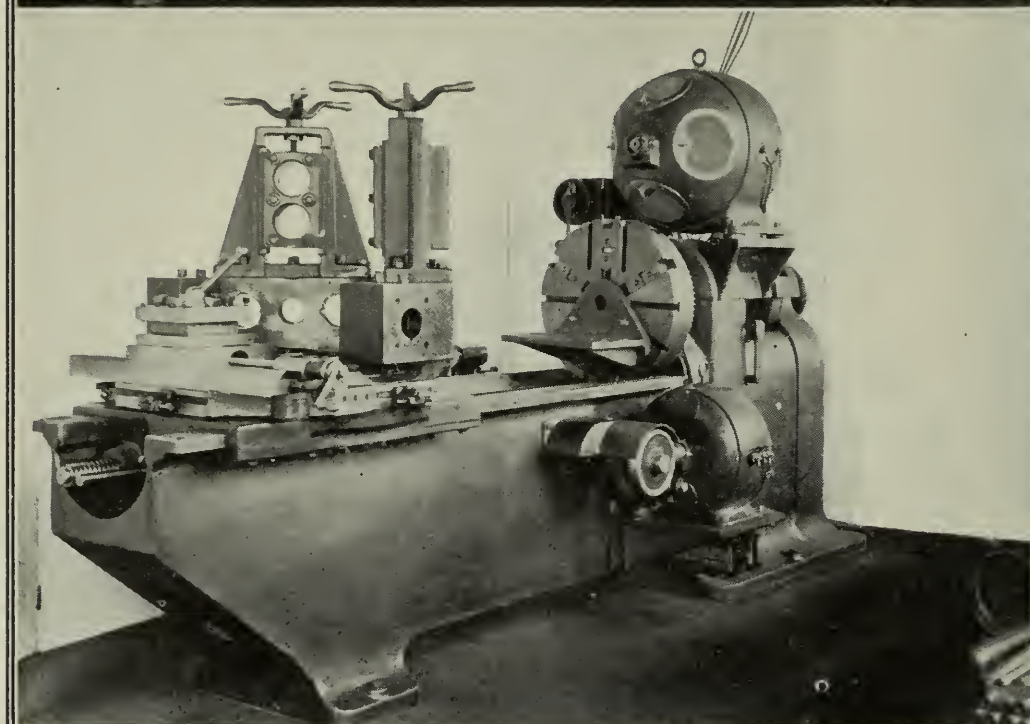
As a matter of fact, there are but four steps in the cones we are considering and, consequently, in view of the varying work and stock that comes to our all-round lathe, we can maintain theoretically proper speeds only four times out of forty-two; or, which is the same thing, about one-tenth of the time, or one hour out of every ten. Nine-tenths of the time our speed requirements will either be too fast or too slow to be met by any one of the four steps. We may fairly assume that one-half of this time the next smaller driven cone would give us a faster speed than we need for the work in hand, and that the other half of the time the next larger driven cone would give us a slower speed than we desire. We cannot avail ourselves of the small cone in the first case, anyway, for the tool would not hold its edge; and in the second case, we must go to the larger cone for the same reason, although the speed will be lower than we might profitably use. In either of these events, we do not get the highest speed suitable to the work in hand and must run nine-tenths of the time at speed averaging



LATHES OPERATED BY ELECTRIC MOTORS.

Above is a turret lathe made by the American Turret Lathe Co., of Wilmington, Del., operated by a 3-horse-power and a 1-horse-power motor; below is a 26-inch Bullard roughing lathe operated by a 10-horse-power 250-volt motor. The electric equipment in both cases is by the General Electric Co.



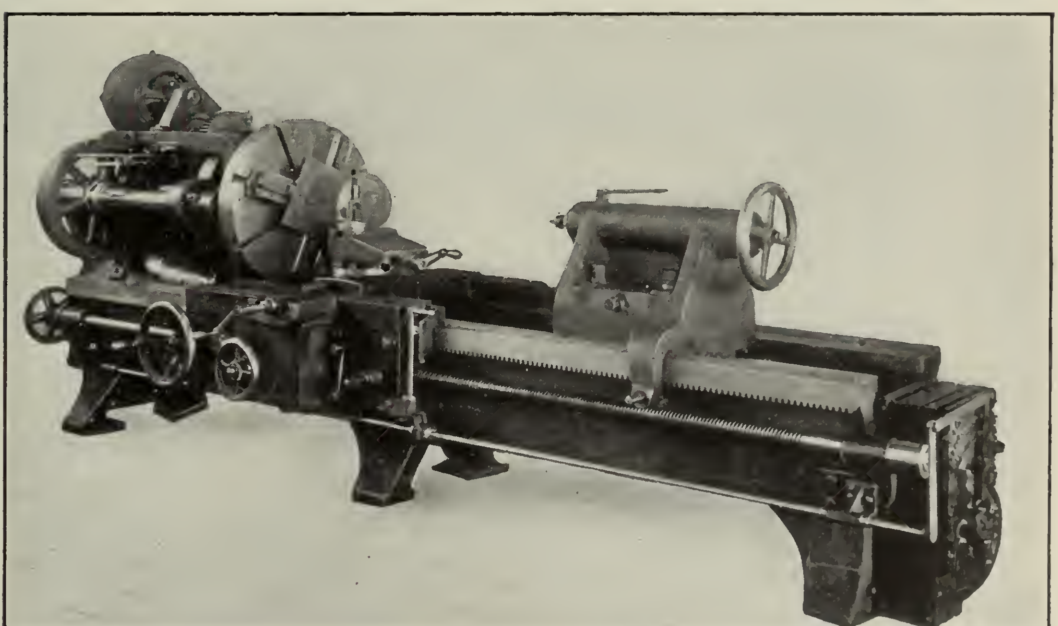


MOTOR APPLICATIONS TO LATHE DRIVING.

Above is a Jones & Lamson turret lathe, with 5-horse-power motor, multiple-voltage speed control; below is a Conradson lathe made by the American Turret Lathe Co. and driven by two motors—a 10-horse-power on the spindle and 3-horse-power on the feed, using multiple-voltage speed control. Both examples are from the Crocker-Wheeler shops and show Crocker-Wheeler equipment.

about one-half those which we might most advantageously employ. Making all reasonable allowances, we shall not be far out of the way in asserting, under these circumstances, that the engine lathe in an ordinary shop, used on all-round work, does not turn out much more than 60 per cent. of what it might otherwise do, were it provided with an efficient and easily manipulated means of changing speed by comparatively small increments and over wide ranges.

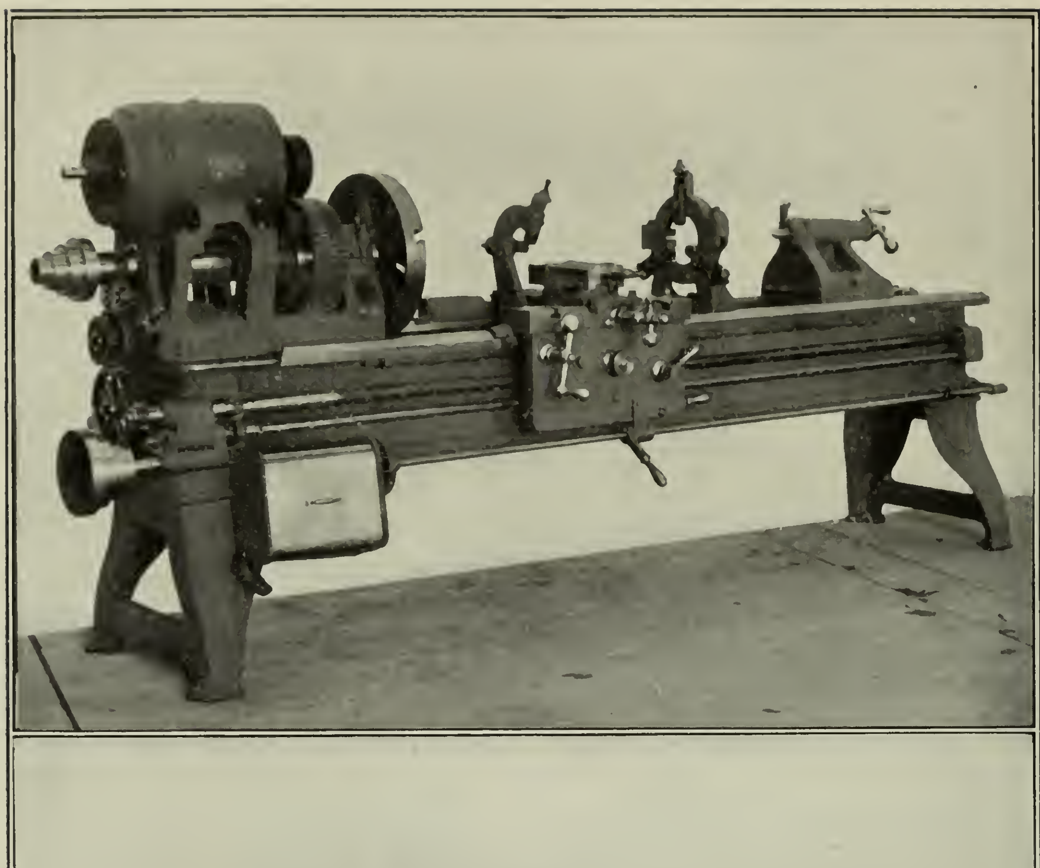
Cone pulleys with forty-two steps are manifestly impractical and even if we had them, it is doubtful if workmen could be induced to shift their driving belts as often as they ought. In any event the attention and labor involved would be prohibitive. An electric motor may be arranged, however, to give large variations of speed control by very slight increments, and the labor and attention of the workmen needed to effect and follow these changes is trivial. The controlling apparatus may be governed by a handle or handles carried on the



28-INCH LATHE DRIVEN BY 3-HORSE-POWER DIRECT-CURRENT MOTOR.
Variable speed control, the controller being operated from the carriage so the operator's eye need not be taken from the chip. Northern Electrical Mfg. Co. and Pond Machine Tool Co.

apron of the lathe and where they may be manipulated without the necessity of the workman taking his eyes from the chip he is cutting.

As the quantity of work performed on such a machine tool is largely proportioned to its cutting speed, it is quite possible by the use of motor-driven tools with good variable speed control, to reduce the losses mentioned very materially and thus largely to increase the product with substantially the same fixed charges. The practical extent

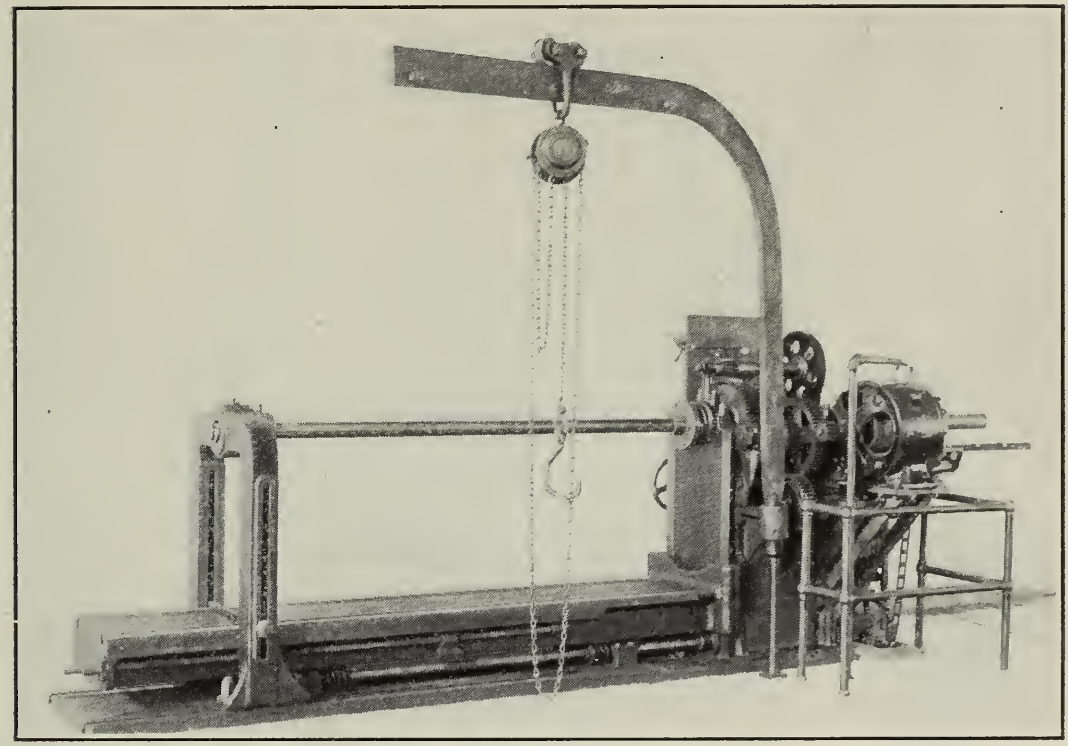


ABOVE IS A 14-INCH LE BLOND LATHE AND BELOW A LATHE BY SCHUMACHER AND BOYÉ, BOTH DRIVEN BY DIRECT-CURRENT MOTORS.

Bullock Electric Mfg. Co., Cincinnati, Ohio.

to which these losses may be reduced or the product increased depends after all, however, upon the local conditions obtaining in each shop and, to an almost equal extent, on the man who attends the machine, the care with which he adjusts his speeds and cuts, and his conscientiousness in keeping them regulated to the work in hand from time to time.

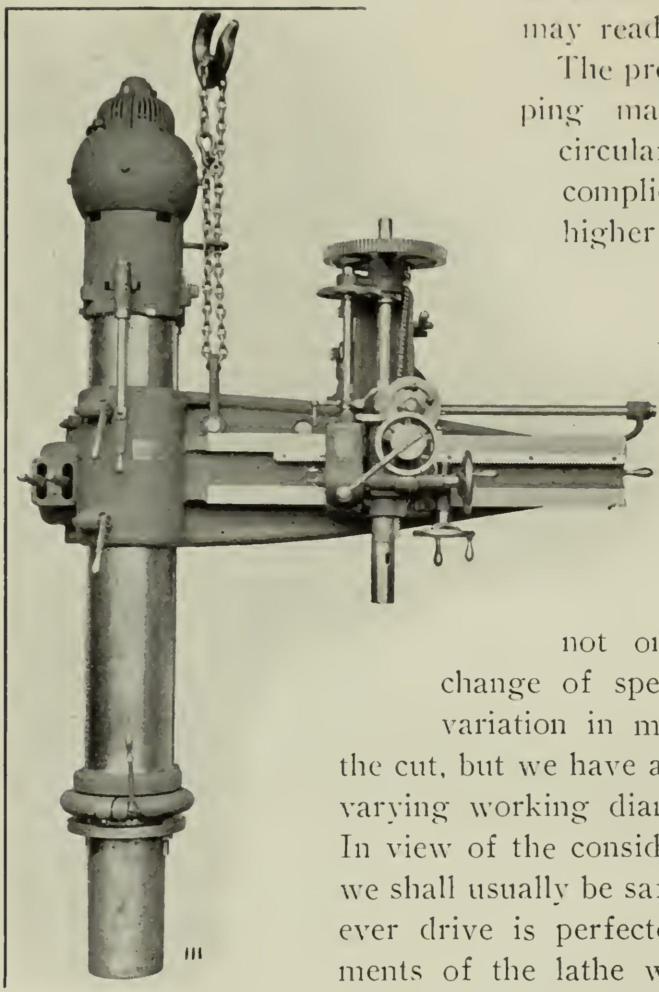
We have considered the speed requirements of the lathe at some considerable length for the reason that they vary so widely and present



HORIZONTAL BORING MILL DIRECT-CONNECTED TO 5-HORSE-POWER MOTOR.
Binsse & Hauschild, Newark, N. J.; General Electric Motor.

one of the most difficult problems to be met in the equipment of machine tools with electric drive.

Boring mills and drills entail similar difficulties in the selection of equipment, although not usually to the extent of those encountered in the consideration of lathe requirements. Stated roughly and in general, grinding machines of nearly all sorts necessitate variable speed control in the proportion of one to two or higher. That is to say, if a grinding machine is to produce its highest output, a speed control must be readily obtainable, not only to correspond with the quality of the wheel used and the work on which it is used, but sufficient to compensate for the wear in the diameter of the wheel. It is very important that the periphery of the grinding wheel should be kept at the maximum cutting speed at all times. Cutting-off machines for operating on pipe, merchant bar, and stock sizes in machinery steel, iron, and shafting, ought to be provided with variable-speed motors. This problem has already been worked out in a very satisfactory manner in several cases, and the time required to cut off a 4-inch shaft, for instance, when an automatic electric control is used, may readily be reduced one half.



BICKFORD RADIAL DRILL DRIVEN BY 5-HORSE-POWER NORTHERN DIRECT-CURRENT MOTOR.

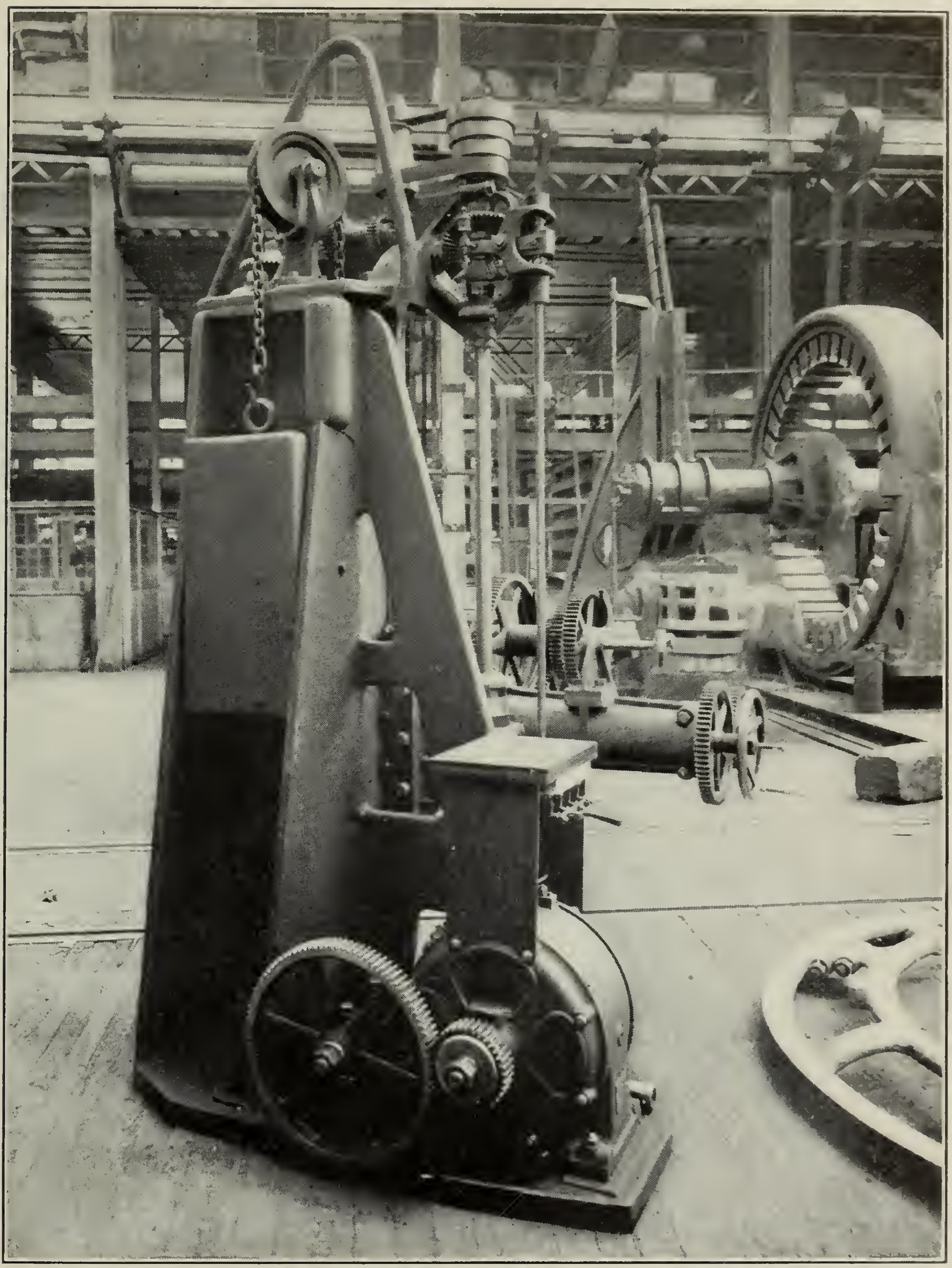
Carried to work by crane. Shops of Dodge Mfg. Co.

The problems involved in equipping machines which effect a circular cut are in general more complicated and require a higher range of speed control than in the case of those machines which operate with a simple rectilinear motion.

In the case of machine tools running a circular or spiral cut, we have not only to provide for the change of speed required to suit the variation in material and character of the cut, but we have as well to provide for the varying working diameters of the tool path. In view of the considerations set forth above, we shall usually be safe in asserting that whatever drive is perfected to meet the requirements of the lathe will often, in a modified and simplified form, meet the requirements of other machine tools employing rotary movement.

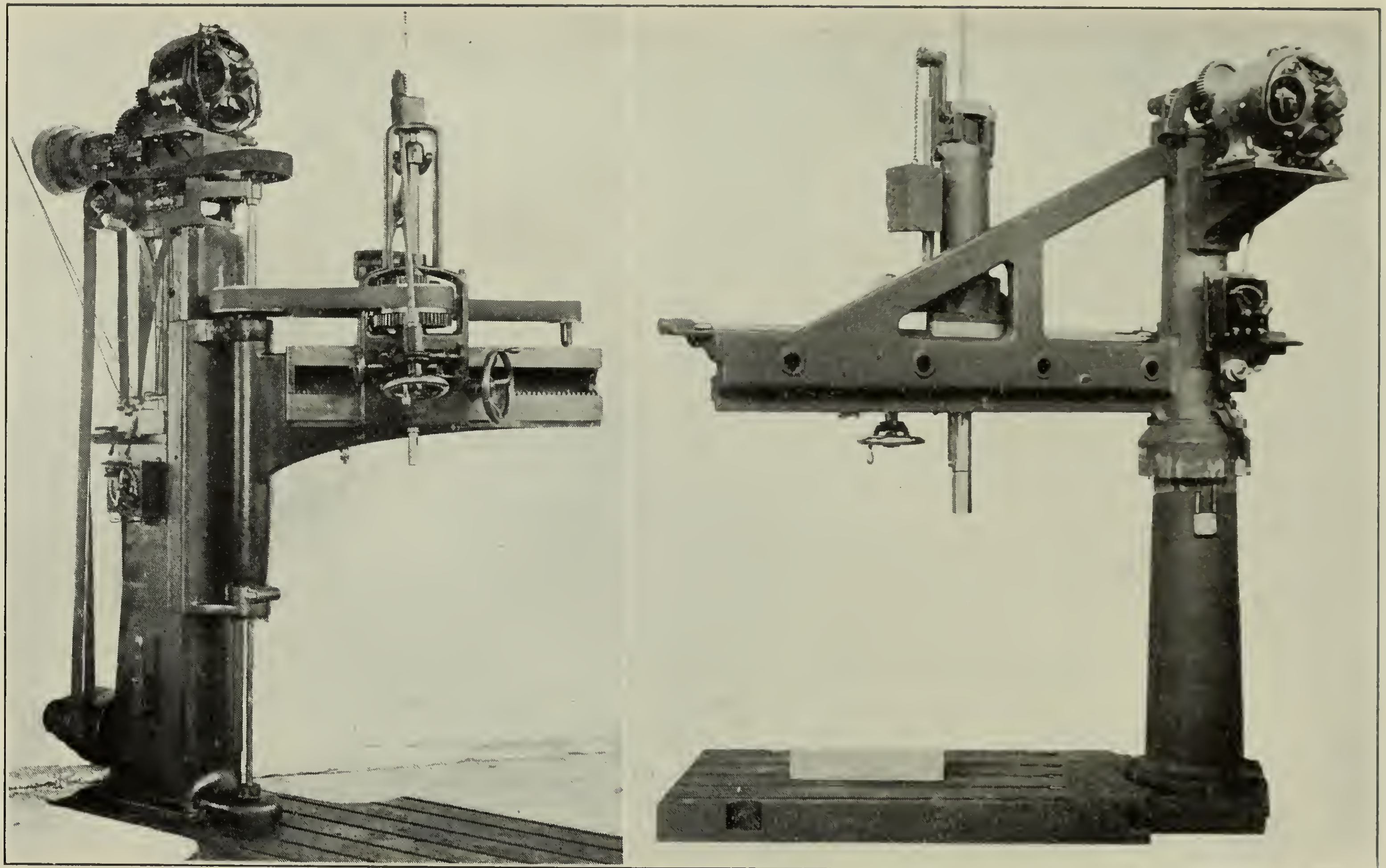
The problem of equipping such machines as planers, key seaters, slotters, and shapers, is in many respects much simpler. Here we rarely have any requirements for speed change, except to meet the needs of cut or material. It is rarely necessary to vary the rate of cut while working on any given surface.

The principle of providing heavily built tools and driving them at their full capacity having been pretty well established, it is interesting to note where the savings lie. Irrespective of increased cost of tools



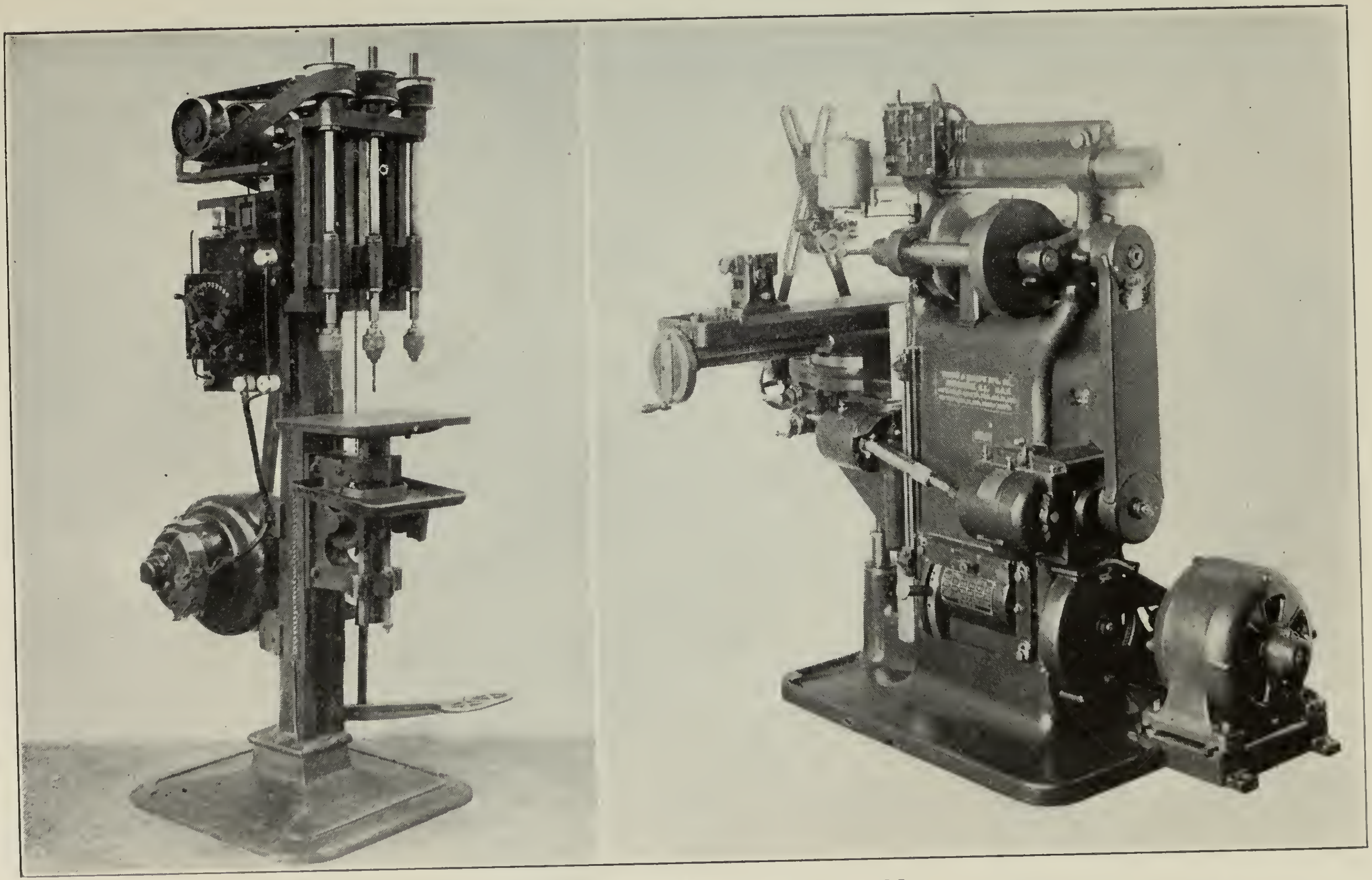
ELECTRIC-DRIVEN PORTABLE MILLING, DRILLING, AND BORING MACHINE.
Driven by Westinghouse alternating-current motor and installed in the works of the Westinghouse Electric & Mfg. Co., East Pittsburg.

and equipment, on which of course a somewhat larger interest charge must be carried, a concrete case will work out something like this: assuming that a shop had a large quantity of steel shafting to rough out, running from 4 to 6 inches in diameter; if an ordinary 26-inch lathe was employed to machine these shafts, a chip 3/16 inch by 1/24 inch



THE ELECTRIC MOTOR APPLIED TO DRILLING MACHINERY.

On the left is a Pond Machine Tool Company's radial drill belted to 3-horse-power shunt motor. On the right is a radial drill by Prentice Bros., of Worcester, with 2-horse-power slow-speed motor. General Electric Co.



ELECTRICALLY OPERATED MACHINE TOOLS.

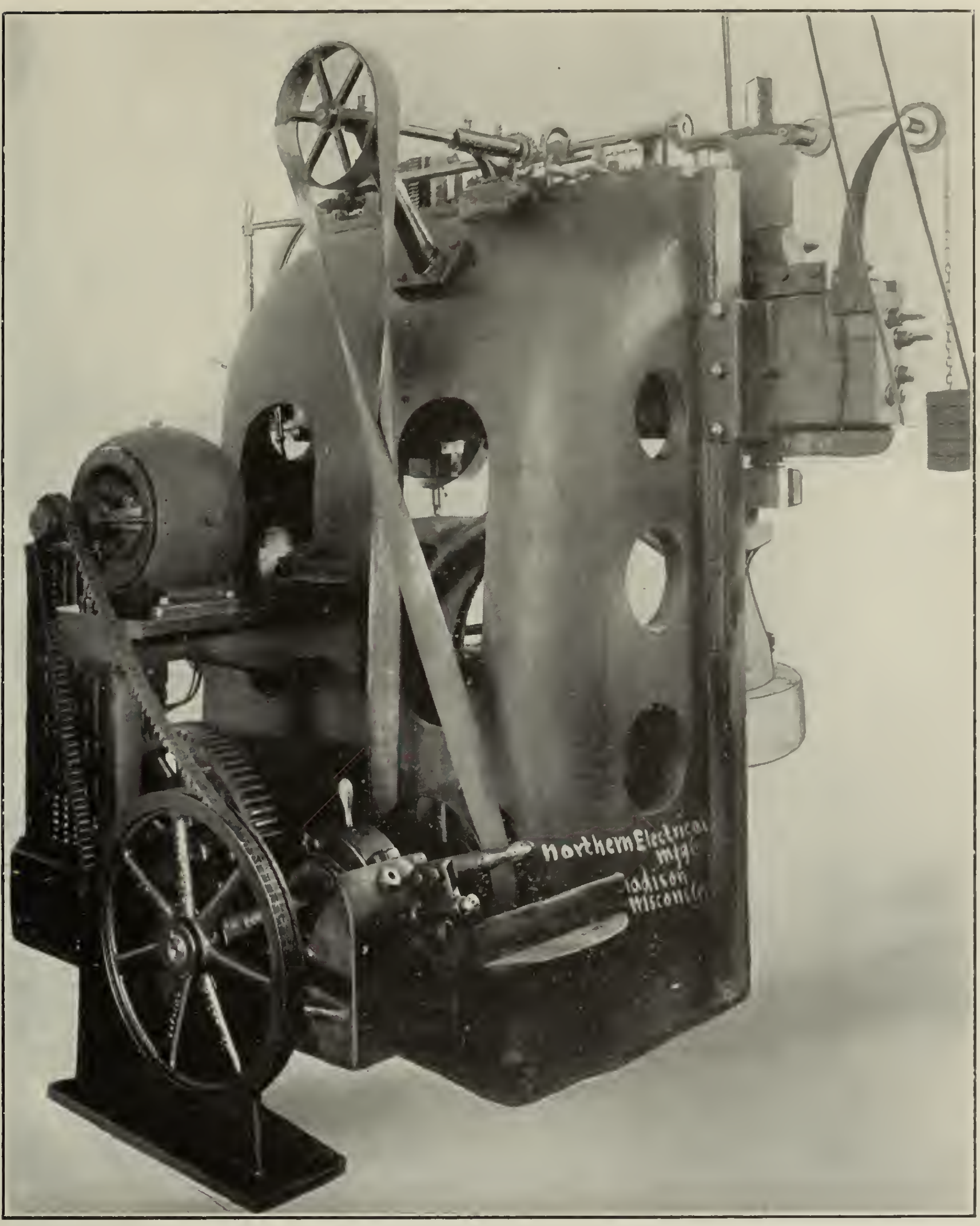
On the left is a Garvin three-spindle drill press, operated by a 2-horse-power 500-volt motor. On the right is a Brown & Sharpe universal milling machine driven by a 2-horse-power alternating-current motor. General Electric equipment.

removed at the rate of 30 feet a minute would perhaps represent the average of ordinary shop practice, and one and one-half horse power would probably be sufficient to pull this cut. With the heavy lathes now made and proper tools, we shall find it quite possible to run with a chip 1/4 inch by 1/12 inch at 120 feet a minute or more, and this will require about fifteen horse power. It will be observed that the ratio of metal removed in a given time, as between the first and second cases, is better than one to ten. Suppose the workmen to be paid 25 cents an hour in either case, then the labor expense of removing a certain quantity of metal would be, in the first case, $2.50, and in the second case, 25 cents. Assuming that the charge for current was 4½ cents per horse-power hour, the cost of power with the light chip would be 68 cents ($1\frac{1}{2} \times 10 \times 4\frac{1}{2} = 68$) and in the second case with the heavy chip 68 cents also ($15 \times 1 \times 4\frac{1}{2} = 68$). Assuming again, to complete the illustration, that the indirect expense of this shop was equivalent to 50 per cent. on its labor pay-roll, we have then, exclusive of power, a cost for the operation of $3.75 by the old method, and 38 cents by the newer method. In other words, the total charge would be $4.43 when much labor and little power was employed, and $1.06 when more power and less labor was employed—a difference in favor of the more modern method of $3.37, exclusive of interest and similar charges on the more expensive tool.

It may be objected by some reader that the data from which these comparisons are made are erroneous and therefore the conclusions worthless. I can only state that I have repeatedly seen work being done in the first way during years past, and during recent years quite frequently, I am glad to say, in the second way.

The apparent necessity of equipping the major portion of the machinery in a shop with electrical appartus capable in itself of producing extreme ranges of speed control, may be found when examined carefully to indicate a poor selection of machine tools or tools not properly adapted to the work in hand. For instance, the necessity of a very wide range of control in a boring mill might perhaps indicate either a shortage of lathe equipment, injudicious selection of sizes, or the need of other smaller and lighter boring mills.

It might be more advisable in some such a case to purchase an extra lathe or small mill with a one-to-two or one-to-four speed change than to attempt a one-to-six or one-to-eight speed change by electrical control on a large mill. The financial aspect from an investment standpoint might be far more favorable in many cases to the purchase of another comparatively simple tool than to tying up the considerable



5-HORSE-POWER NORTHERN MOTOR DRIVING A 51-INCH NILES BORING MILL THROUGH RENOLD SILENT CHAIN.

investment in the larger tool with its complicated and expensive speed-changing equipment, in order to meet the requirements of some line of small work. Each case of this nature, however, must be decided on its merits.

The question is frequently asked: "What power will be required to operate such and such a machine tool?" This question can not be answered in as off-hand a way as it is usually put. The power will vary with the design of the tool, the care with which it is kept up, the class of work turned out, the material to be machined, the amount of metal to be removed in a given time, and the workman who operates it. I know of no reliable rule which includes the variables referred to. Each case must be considered by itself. A few general statements meeting average conditions may perhaps be hazarded, but if heavy tools and air-hardened steels are used and production pushed to the limit of the tools, from two to three or four times this power may be required. The rate at which the work may be pushed depends largely on the construction and rigidity of the tool.

Lathes.

22 in. to 24 in. . .	2-horse-power motor
30 in. to 36 in. . .	3 " " "
48 in. to 54 in. . .	5 " " "
60 in. to 72 in. . .	7½ " " "

Boring Mills.

48-inch swing. .	5-horse-power motor
72-inch " . .	7½ " " "
96-inch " . .	10 " " "
16-feet " . .	15 " " "

Planers, Single Head.

26 by 26.	5-horse-power motor

Planers, Double Head.

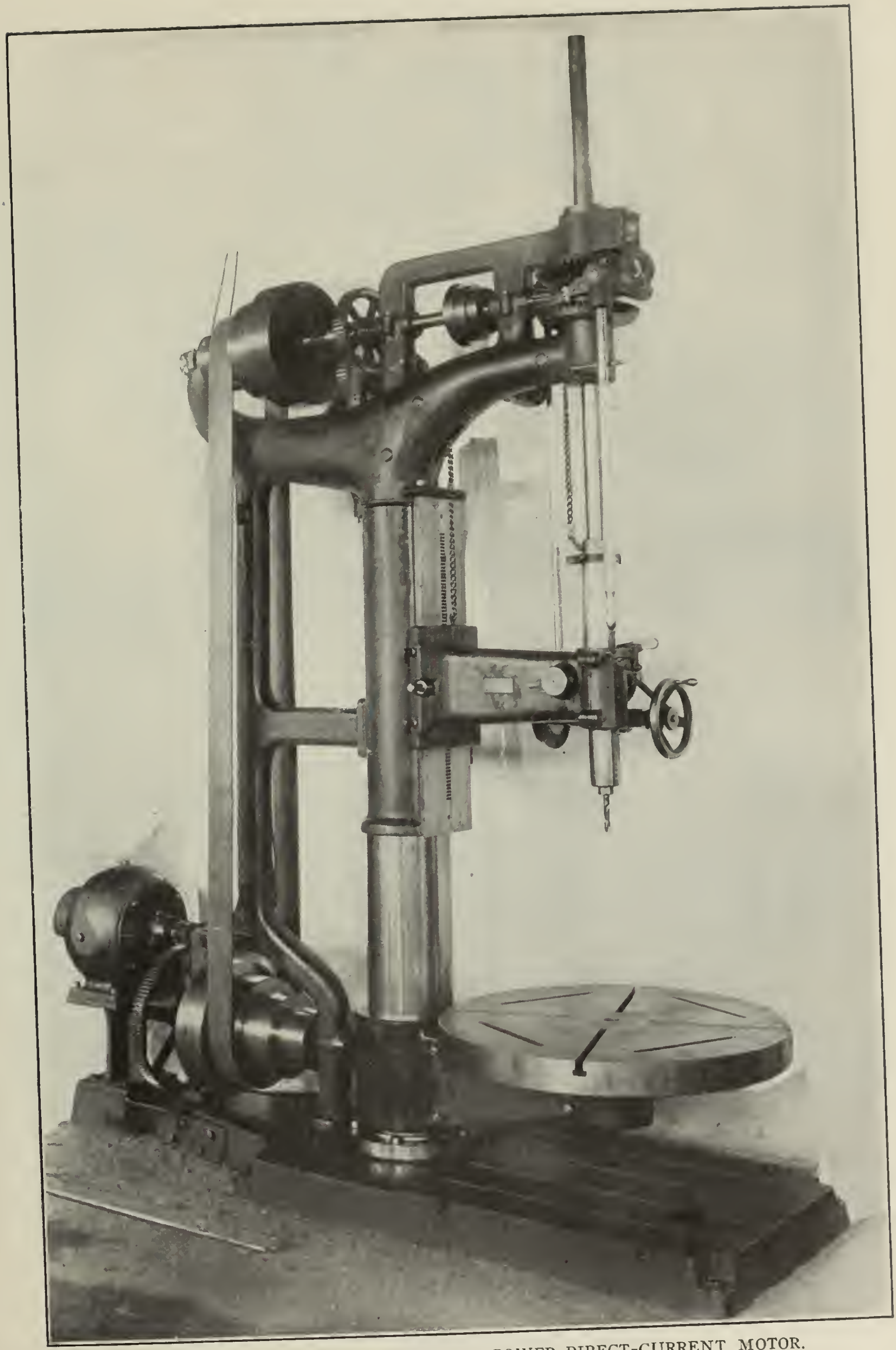
30 by 30, 36 by 36	10 " " "
48 by 48, 54 by 54	15 " " "
60 by 60.	20 " " "

Drill Presses.

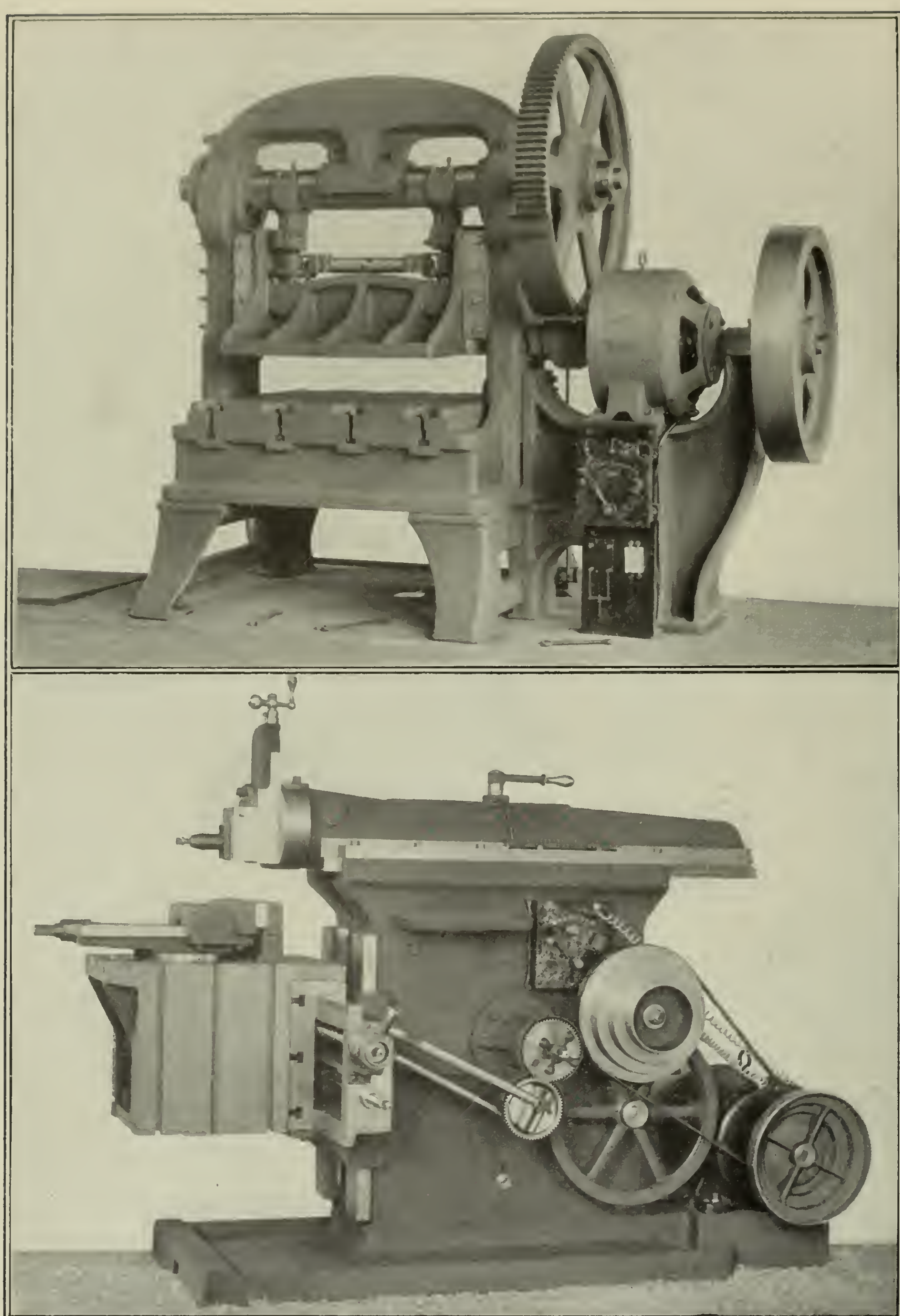
20 inch, 24 inch	2-horse-power
36 inch, 40 inch	3 " "
50 inch, 60 inch	5 " "

We may again emphasize as a leading principle that it is of the highest importance in equipping machine tools with motors; to avoid the adoption of any apparatus which will oblige the workman to assume for its proper operation any material addition to the mental or manual effort which he is already called on to exercise in the purely mechanical operation before him; that is to say if, in order to produce speed changes or variations of speed, a workman must undertake either laborious mental or physical exertion or the exercise of concentrated attention to attain the desired results, then one of two things will happen; either, from divided attention, the quality of his product will suffer, or, what is more likely, he will not use his equipment to the best advantage and the quantity of the product will suffer; and in either case the proprietor will not receive due benefit from his investment.

It is, therefore, absolutely essential that all the driving apparatus and mechanisms connected therewith be of the simplest design consistent with the results to be obtained, and that changes of speed be controlled through the simplest operations and by some device which may be manipulated preferably with one hand, without the workman being obliged to change his position, without the exercise of sensible labor, and without obliging him to divert his attention and eyes from the chip he is removing; hence, systems requiring a multiplicity of



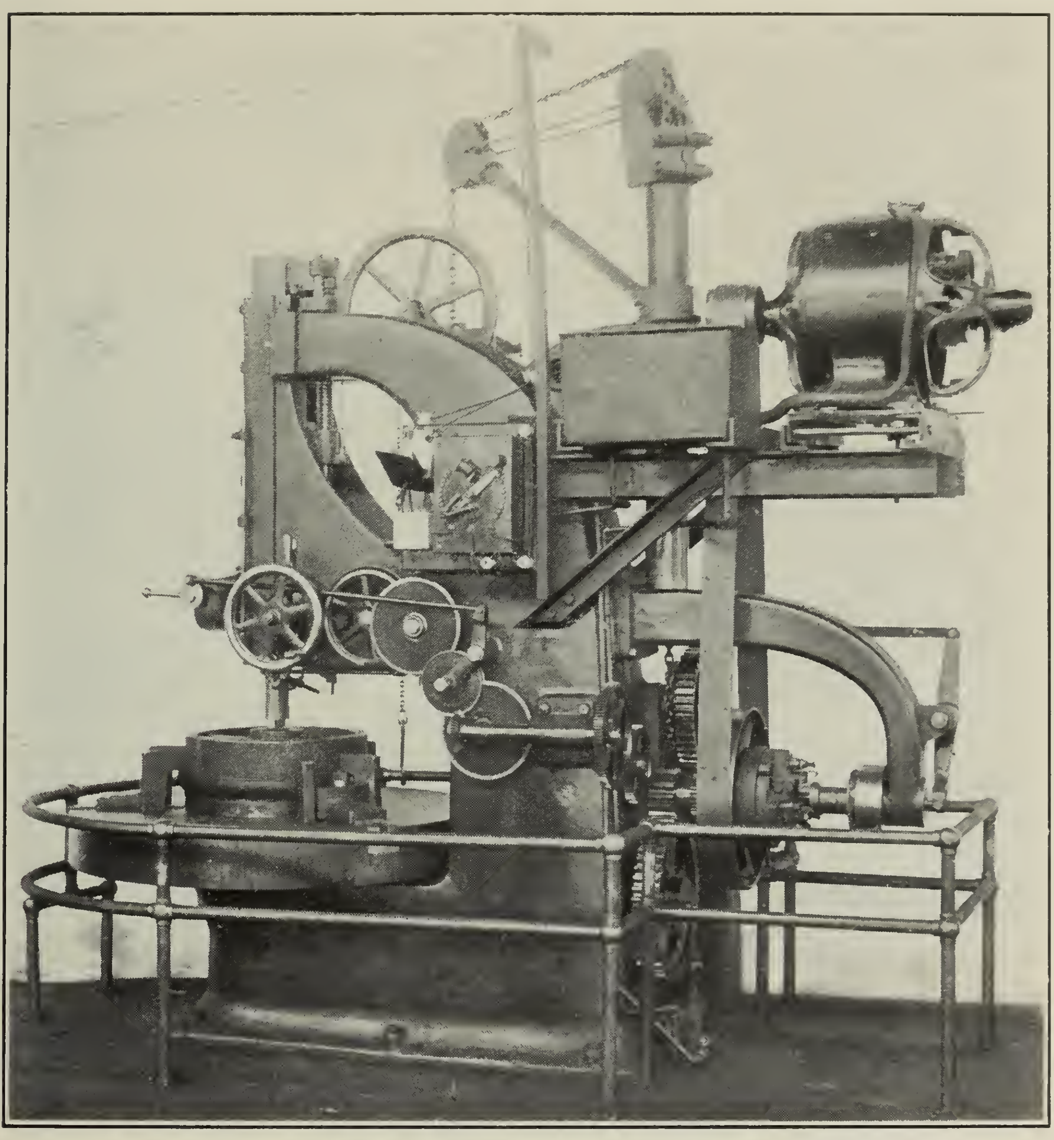
48-INCH DRILL DRIVEN BY 5-HORSE-POWER DIRECT-CURRENT MOTOR.
Cincinnati Machine Tool Co. and Northern Electrical Mfg. Co.



THE UPPER FIGURE SHOWS A BLANKING PRESS BY THE TOLEDO MACHINE AND TOOL CO., THE LOWER A SHAPER BY THE CINCINNATI MACHINE TOOL CO., BOTH DRIVEN BY BULLOCK MOTORS.

switches or manipulating handles, seem destined to fail in practical operation ultimately.

The expense of equipment must also be borne in mind continually, for equipment adds to capital account, and increased capital account means increased interest charges; and usually the more expensive

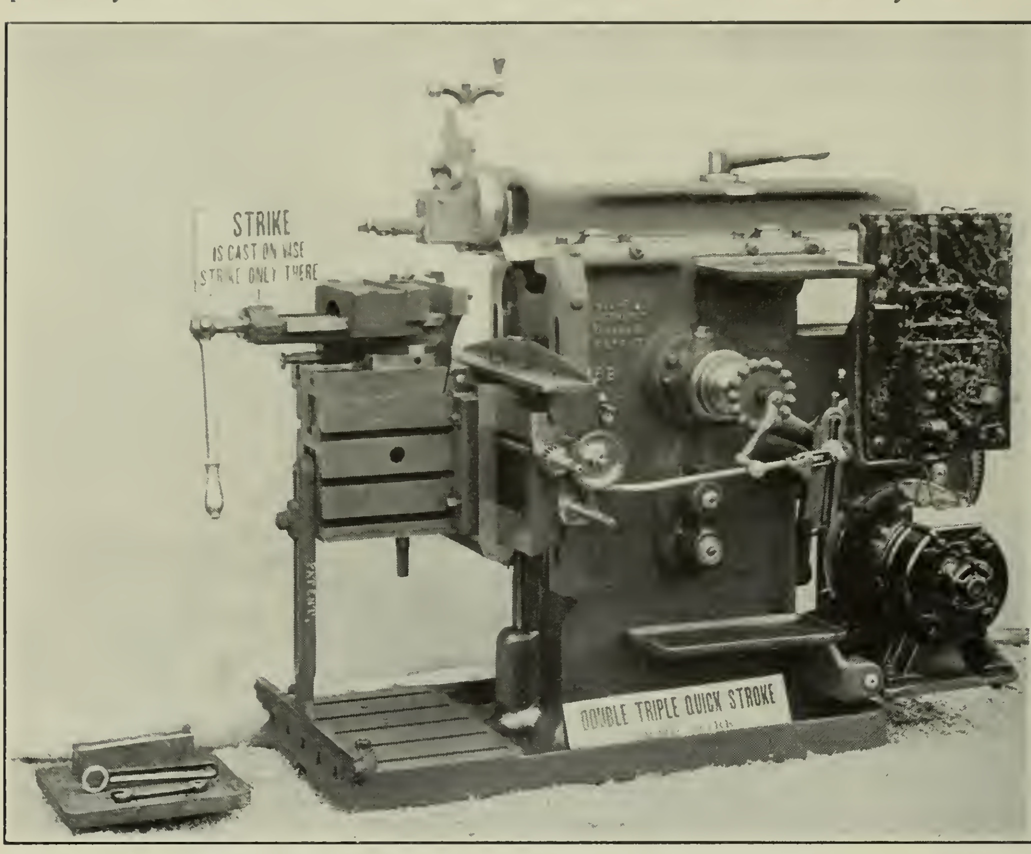


SELLERS BORING MILL DRIVEN BY 7½-HORSE-POWER GENERAL ELECTRIC MOTOR.

the apparatus, the more complicated it is and, consequently, the greater the continuous cost of its up-keep.

For all-electric control, a motor may be readily built and operated on the multi-voltage system with four or more wires, having several hundred per cent. in speed range; but this means the installation of a much larger machine and, consequently, a much more expensive machine than would be required, were only a moderate portion of the control electrical and the remainder mechanical. Again, with such apparatus the cost of providing current supply, wiring, and controllers, is greatly increased.

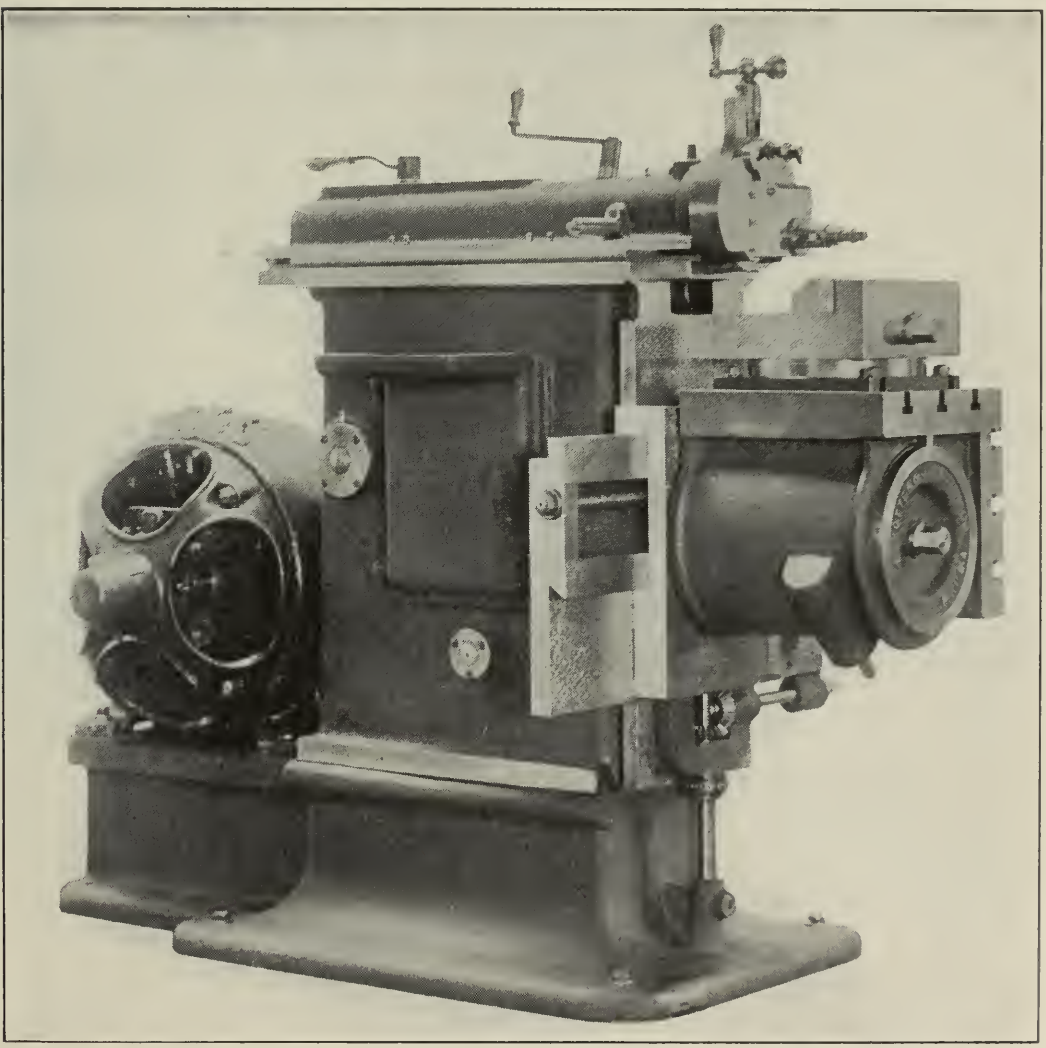
There are, undoubtedly, circumstances where the installation of such apparatus is justifiable, but the greater number of ordinary cases may perhaps be better served by a control partially electrical and partially mechanical, or electro-mechanical. We can easily build a



EBERHARDT SHAPER WITH DIRECT-CONNECTED SPRAGUE MOTOR, 3-HORSE-POWER.

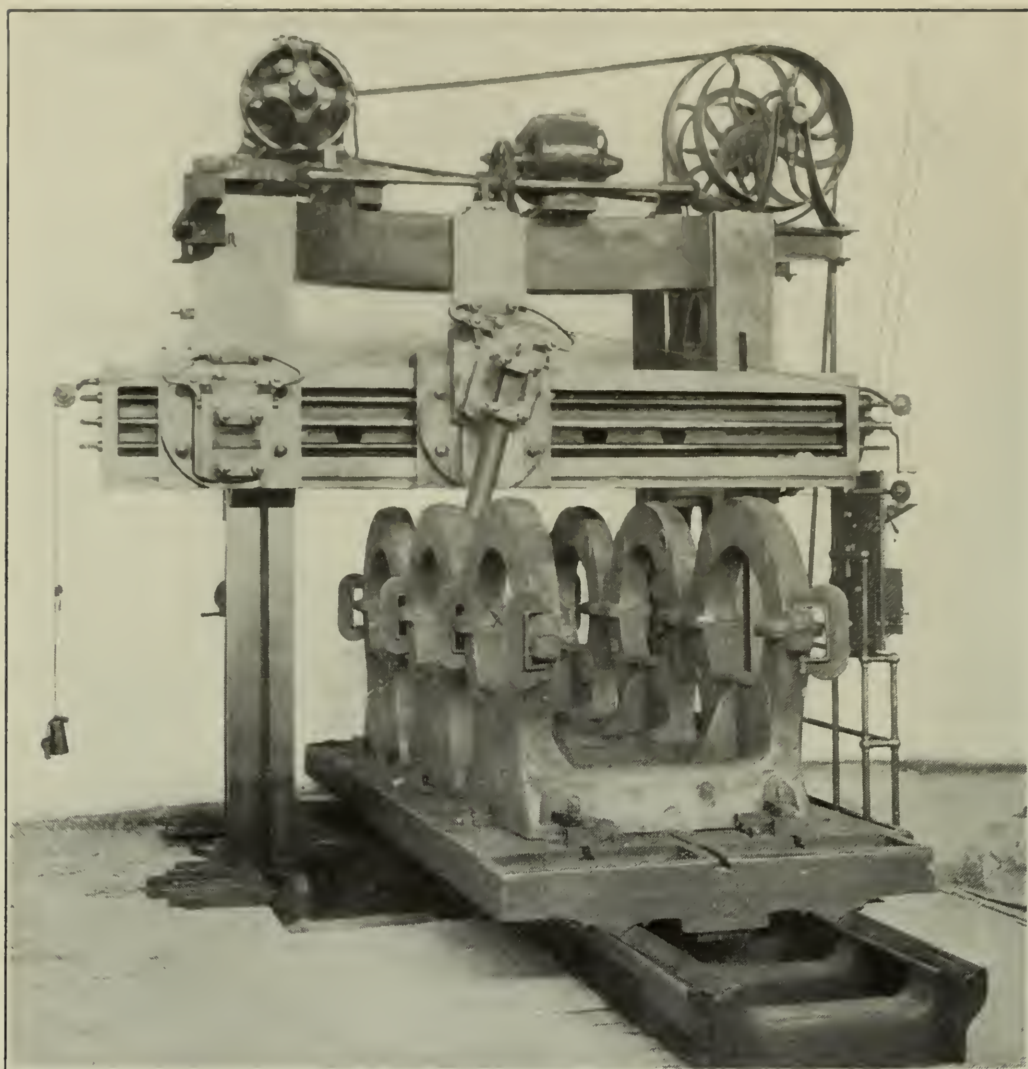
motor to be operated on the two-wire system with a speed range of one to two by field control that will not be excessive in weight or expensive in price, and this same motor on the three-wire system may have a range of one to four; and my preference is generally toward the use of motors in which greater speed ranges than this are not attempted, everything taken into consideration.

Large steps in speed change may be well taken care of mechanically, either by gears, short belts and cones, or rarely by friction drives, and the changes and variations from and between one of these steps to another may be accomplished by the motor. In the majority of cases, these coarser speed changes may be made manually without seriously diminishing the efficiency of the tool, for it is quite rare that anything like the whole possible range of speed control is ever required during any one operation. With such mechanical changes and a motor possessing speed ranges of one to two, or one to four, to fill in the gaps between the mechanical changes, very satisfactory results are possible and at reasonable cost. It is a comparatively easy matter for a workman, when going into a new job, to arrange mechanically for the average speed required; afterwards, and during the operation to be performed, his motor will give him all the variation usually needed. No thoroughly satisfactory method of effecting the coarse mechanical speed changes previously alluded to through electrical control



POTTER & JOHNSON SHAPER DRIVEN BY 3-HORSE-POWER GENERAL ELECTRIC MOTOR.

is known to me as being in commercial operation at the present time. Systems comprehending this idea are being worked out, however, and when completed will largely simplify the problems now before us. With coarse mechanical speed steps electrically governed and thrown in and out in proper sequence with the finer speed changes obtained



84-INCH PLANER, WITH 3-HORSE-POWER SHUNT MOTOR FOR RAISING AND LOWERING CROSS RAIL AND 7½-HORSE-POWER COMPOUND-WOUND MOTOR BELTED TO BED PLATE.
Pond Machine Tool Co. and General Electric Co.

in the motor, all accomplished by one easily manipulated controller, we shall have attained a system which gives promise of being superior to anything now in use.

There is an economic side to this whole question which we may well touch on at this point. It is an element of human nature to desire to share any benefits which one is instrumental in obtaining for another, and I believe that nothing would make for better results in causing machine tools to be handled intelligently and kept at their highest point of productive efficiency than to introduce more widely in shops and factories some method of profit sharing whereby the workman might receive a sensible reward proportioned to the exercise of extraordinary care, judgment, and faithfulness in his endeavor to obtain the maximum quantity of perfect work.

A PRACTICAL SYSTEM OF MINE ACCOUNTING.

By E. Jacobs.

Mr. Jacob's article in our preceding number formulated the general principles which must be followed out in any comprehensive and efficient system of mine accounts. The paper now presented gives a brief, concrete example of a plan in actual use. It has the same definite, practical character as the series on shop accounts lately closed in The Engineering Magazine.—The Editors.

FOLLOWING last month's review of "The General Principles of Mine Accounting," a brief outline will now be given of a system of mine accounting or cost keeping in use at several mines in British Columbia, and stated to have been obtained from offices of important mines in the United States. This summary, however, must be prefaced by an admission that it has been found difficult to convey in writing, within reasonable space limits, an adequate idea of any such system. But since a few weeks' practical experience of its working, or even an examination of books and forms when in use in carrying it out, is not practicable to the great majority of readers, the best must be made of the position.

Nearly all the examples of arrangement and rulings of books and forms here given are taken from those in use at the Le Roi and Le Roi No. 2 mines at Rossland, British Columbia. The accompanying information, though, does not necessarily follow closely in all details the methods employed in the offices of those mines, although their principal features are observed. A similar system, with some variations, is in force at other mines at Rossland, and as well at the Snowshoe mine in the Boundary District of British Columbia.

It is claimed for this system (in connection with which daily reports from shift bosses, foremen, mechanics, time keepers, store keepers, and others required to furnish information relative to either labor or supplies, are obtained and carefully checked and recorded), that it secures accurate returns of the men's time and the materials or supplies used, checks the time of every man employed in or about the mine, and supplies data for a daily tabulated report to the manager, which, though in condensed form, gives him sufficient information for the

LE ROI No. 2, LIMITED.

SHAFT DAILY LABOR REPORT.

NOTE on the back of this report the names of any new men; also men who do not work a full shift.

__________ MINE 11-7 O'CLOCK SHIFT __________ 190_

NO. MEN	HOURS	MINUTES	OCCUPIED BY	SUNDRIES
			DRILLING	STICKS POWDER USED
			BLASTING	FEET FUSE USED
			SHOVELING	HOLES BLASTED
			TIMBERING	CARS HOISTED
			LOWERING PUMP	SETS TIMBER

PROGRESS OF SHAFT WAS DELAYED HOURS MINUTES, BY

__________ SHIFT BOSS.

1. SHIFT BOSS'S DAILY REPORT, EXPLORATION OR DEVELOPMENT ACCOUNT. Original is 6 by 4½ inches.

LE ROI No. 2, LIMITED.

ORE BREAKING DEPARTMENT __________ FT. LEVEL

NOTE on the back of this report the names of any new men; also men who do not work a full shift.

__________ SHIFT __________ 190

NO. OF FLOOR EAST	NO. OF FLOOR WEST	NO. OF MEN DRILLING	NO. OF MEN SHOVELING	TIMBER	TIMBER	TIMBER	NO. MACHINES	TOTAL NO. MEN

TOTAL OUTPUT ORE FROM STOPES __________

__________ SHIFT BOSS

2. SHIFT BOSS'S DAILY REPORT, ORE-PRODUCTION ACCOUNT. Original is 6¼ by 4½ inches in size.

most effective disposition of his working force and the consequent more economical management of the mine.

Several of the forms used in making the reports above referred to are reproduced herewith. Most of them are self-explanatory, and they will serve to indicate the nature of the information required from those whose duty it is to supply the particulars necessary for a systematic check upon labor and supplies. It will be noted that No. 1 is

West Le Roi Mining Company, Limited.

BLACKSMITHS' LABOR REPORT.

________SHIFT________________190

OCCUPATION	No. Men	Rate Per Day		
Foreman Blacksmith,				No. Pieces Machine Steel Sharpened,
Blacksmiths,				No. Pieces Hand Steel Sharpened,
Blacksmith Helpers,				No. Picks Sharpened,
Sharpeners,				No. Pieces Machine Steel Made.
Sharpeners. Helpers,				No. Pieces Hand Steel Made.
				No. Pieces Steel Returned Broken.
				Sacks Coal Used.

Remarks.

____

Head Blacksmith

3. FOREMAN BLACKSMITH'S DAILY REPORT.
Original is 7 by 7 inches in size.

an example of the reports the shift bosses in the mine are required to furnish daily in connection with exploration or development work; No. 2 deals similarly with ore production; No. 3 is an example of the report a foreman mechanic has to send in; No. 4, not shown, is a powderman's daily report of the stocks of powder of each grade, the caps and fuse used, designated by "level" and "place." In a measure, Nos.

RM. NO.27 1-1902

NOTE This Form is to be filled in and forwarded to General Manager not later than 10 a.m. each day

LE ROI NO. 2, LIMITED.

EMPLOYED IN MINING OPERATIONS UNDER DATE, ________ 190__

		MORNING SHIFT							AFTERNOON SHIFT							NIGHT SHIFT							
WORKING	LEVEL	Drills Working	No. Cars	Machine Men	Shovelers	Trammers	Timbermen	Total Men for Shift	Drills Working	No. Cars	Machine Men	Shovelers	Trammers	Timbermen	Total Men for Shift	Drills Working	No. Cars	Machine Men	Shovelers	Trammers	Timbermen	Total Men for Shift	Total Men for Day
TOTALS																							
Gen'l U'derg'd Emply's																							
FOREMAN																							
SHIFT BOSSES																							
POWDERMEN																							
TRACKMEN																							
CHUTEMEN																							
NIPPERS																							
SKIP TENDERS (NEW SHAFT)																							
SKIP TENDERS (OLD SHAFT)																							
PIPEMEN																							
ENGINEERS																							
Total Emply'd U'derg'd																							

5. DAILY TABULATED REPORT TO MANAGER, UNDERGROUND ACCOUNT.
The original is 9 inches wide and 17 inches high, giving much more space for entries above the "Totals."

1, 2, and 3, besides showing the number of men at work and the time they worked, record work done and some of the stores used. Nos. 5 and 6 comprise the daily tabulated report to the manager, to whom it must be made by a fixed hour every morning. The former shows all labor, properly classified, employed in each separate underground working; also number of machine drills working and cars sent out. The latter gives all surface labor, also classified. No. 7 is a weekly labor report, embracing all labor employed at the mine, whether underground or on the surface, summarizing the daily reports and exhibiting the total cost of labor for the week, this last being especially useful for purpose of comparison. No. 8 is a copy of a leaf taken from one of the books kept by the time keeper, this being a monthly summary of all development (or exploration) labor, compiled from the shift bosses' and other daily labor reports, such as Examples Nos. 1, 2 and 3. Among the remaining forms of report in use is a Mine-Machinery Installation Labor Report, which shows the number of men employed in installing machinery, rate of each man's pay per day, and nature of work performed. In connection with this there is, where of sufficient importance to warrant it, a report for each separate piece of machinery in course of installation at the mine. Two other reports that may be mentioned are, (1) a monthly ore-production report for each

FORM NO.26—1-1902-500
SHEET NO.2

LE ROI NO. 2, LIMITED.

SURFACE EMPLOYEES UNDER DATE, ______________ 190______

PLACE	CLASS OF LABOR	Day Shift	Night Shift	TOTAL	PLACE	CLASS OF LABOR	Day Shift	Night Shift	TOTAL
Blacksmith Shop					Carpenter Shop				
	Blacksmiths					Foremen			
	Strikers					Carpenters			
						Sawyers			
Stables						Sawyers' Helpers			
	Teamsters					Laborers			
	Laborer					Yardmen			
Hoist Room					Compressor				
	Engineers					Engineers			
	Firemen								
Boiler Room									
Sorting Room									
	Foremen								
	Sorters								
	Carmen								
Surface Tram to Railway									
	Brakemen								
	Carmen to Tram								
	Loaders at Car								
	Tram's to Ore Bins								
	" to Waste Dump								
	Total					Total			
					TOTAL SURFACE EMPLOYEES				
					BROUGHT FORWARD UNDERGROUND DEPT. SHEET NO. 1				
					TOTAL EMPLOYED.				

6. DAILY TABULATED REPORT TO MANAGER, SURFACE ACCOUNT.

Original is 8½ by 14 inches, giving more space for entries as indicated by break shown near the foot.

individual stope, showing each day's record of number of shifts engaged in drilling, blasting, timbering, and shoveling, quantity of powder and fuse used, number of holes blasted and cars of rock hoisted, and (2), a daily diamond-drill report, giving details of work performed and the geology of the country drilled through. It may be added that at one mine using the system under notice books of 100 pages, each ruled and printed as example No. 9, are in use, these allotting a full

LE ROI No. 2, LIMITED.

WEEKLY MINE LABOR REPORT

Week Ending____________________190

OCCUPATION	SHIFTS	RATE PER DAY		TOTAL
FOREMEN				
SHIFT BOSSES				
HEAD TIMBERMEN				
TIMBERMEN				
TIMBERMEN				
MACHINE MEN BREAKING				
MUCKER BOSSES				
SHOVELERS STOPE				
POWDERMEN				
TRACKMEN				
PIPEMEN				
PUMPMEN				
LADDERMEN				
SHOOTMAN				
SHOOTMAN HELPERS				
NIPPERS				
SKIP TENDERS				
SKIP TENDERS HELPERS				
BLACKSMITHS				
BLACKSMITHS				
BLACKSMITH HELPERS				
TOOL SHARPENERS				
TOOL SHARPENERS HELPERS				
ENGINEERS, COMPRESSOR				
FIREMEN, COMPRESSOR				
ENGINEERS, HOIST				
FIREMEN, HOIST				
MECHANICAL FOREMAN				
HEAD MACHINIST				
MACHINIST				
TRAMWAY				
TRAMWAY				
TRAMWAY				
NIGHTWATCHMAN				
HEAD CARPENTER				
CARPENTER FOREMAN				
CARPENTERS				
LABORERS				
TEAMSTERS				
BOSS ORE BINS				
ORE SORTERS				
CARMEN				
TOTAL				
NO. MACHINES SHIFTS ON FT. LEVEL.				
NO. MACHINES SHIFTS ON FT. LEVEL.				
NO. MACHINES SHIFTS ON FT. LEVEL.				

OCCUPATION	SHIFTS	RATE PER DAY		TOTAL
SINKING MACHINEMEN				
SHAFT TIMBERMEN				
SHAFT HOISTMEN				
DRIFTING MACHINEMEN, Ft. level				
DRIFT SHOVELERS, FT. LEVEL				
DRIFTING MACHINEMEN, Ft. level				
DRIFT SHOVELERS, FT. LEVEL				
CROSSCUTTING MACHINEMEN, FT. LEVEL				
CROSSCUTTING SHOVELERS, FT. LEVEL				
DEVELOPMENT TIMBERMEN				
DEVELOPMENT TIMBERMEN, HELPERS				
RAISING MACHINEMEN, FT. LEVEL				
TOTAL,				
NO. MACHINES SHIFTS ON FT. LEVEL.				
NO. MACHINES SHIFTS ON FT. LEVEL				
NO. MACHINES SHIFTS ON FT. LEVEL.				
NO. MACHINE DRILLS SHARPENED.				

7. WEEKLY REPORT OF ALL LABOR EMPLOYED.

The original is 8 inches wide by 11½ inches high.

page to each man employed. They show the nature of the work done by each man the month through, and so admit of a monthly analysis of labor being made up in the mine office should this duty not be intrusted to a time keeper.

LE ROI No. 2, Limited

Summary of Development Labor at ______________________ Mine

Month of ______________________ 190

DATE	No. SHIFTS						Sticks Powder	Feet Fuse	Holes Blast'd	Cars Hoist'd	
	Drilling	Blasting	Timber	Shoveling							
1											
2											
3											
14											
15											
Totals											
Av. Per Foot											

8. TIME KEEPER'S MONTHLY SUMMARY OF EXPLORATION LABOR.

To simplify the engraving, the form is shown in single column only. The original is in double column, providing for 31 days, and the "totals" of course appear under 31 in the right hand column. Original is 8½ by 11½ inches.

What is known as the "voucher system" is employed in connection with this method of cost keeping. The form of voucher is that in general use. It has printed on its reverse or back the names of the accounts, divided and arranged in similar order to that appearing in the book of record designated the Grand Journal. It is a general, though not an universal, custom to require merchants and others to supply invoices in duplicate or triplicate, one copy being attached to the original voucher sent to the head office, one to the duplicate voucher kept on file in the mine office, and, sometimes, a third copy for the mine store keeper. Where the head office is distant from the mine it is usual to have all vouchers and payrolls made up and signed in duplicate, so that a complete record of, and receipts for, all expenditures may be on file at both head and mine offices.

The payroll is made out in the form in ordinary use, having columns ruled to meet the requirements of the mine. The labor charges it covers are apportioned to the various accounts concerned. It is treated as a voucher, entered in the grand journal as such, and its distribution narrated in necessary detail, as shown by specimen entry, Example No. 10. The total is a credit for the bank account, and the corresponding debit total is made up by the several debits charged to their respective accounts through their proper divisions of the grand journal.

The principal books in use are the ordinary double-entry journal and ledger, a cash journal arranged in a series of columns, a book known as the grand journal, and a trial-balance book. Another book, called a stores journal, is sometimes used as a subsidiary to the grand journal. The ordinary journal is used for every class of entry not coming under the headings of the grand journal. The use of the cash journal appears to be optional, cash being journalized where it is dispensed with. At the Le Roi, No. 2, the grand journal is regarded as the principal book of original entry, the ordinary journal being called the side journal, but at the Snowshoe the position is reversed, the ordinary journal being treated as the principal book of original entry and the grand journal as an auxiliary book. There are, of course, subsidiary books, each office having its own methods in keeping records of the many details that are finally condensed into the entries appearing in the main books. These are adapted to the particular requirements of each individual mine, as experience shall determine.

The grand journal is the voucher record book, and in it the principle of double entry is preserved all through. It is a large book, its folios being 18 inches in depth and 46 inches in width, or 23 inches for each page. It has a number of divisions and these are subdivided as required for the classification of expenditures. The accompanying example (No. 10) shows the arrangement of the accounts, divided and subdivided. The first money column contains the total of every voucher entered in the book and the grand total of all amounts shown in this column equals that of all other columns, first of the debits and next of the credits, in the record excepting those under the division "Distribution." Following the date column are the two headed Dr. and Cr., respectively, these columns showing the division numbers, for ready reference. The use of the "Particulars" column is shown by specimen entries, to which further reference will presently be made. Divisions Nos. 1 and 2 in the Le Roi accounts were used for entering stores and machine-work transactions that company had with

No ______________

Name ______________

Date	Exploration	Ore Production	Mine General		OCCUPATION ______ RATE $______PER DAY LOCATION OF WORK
1					
2					
3					
29					
30					
31					
					Exploration @ $
					Ore Production @ $
					Mine General @ $
					@ $
					@ $
					TOTAL $

9. PAGE FROM SNOWSHOE COMPANY'S TIME BOOK.
Original is 4 inches wide by 9¼ high.

its parent company, the British America Corporation. The columns are retained (without the original headings) in the example here given with the object of preserving the Le Roi numbering of the other divisions, but they are otherwise utilized as shown. The first shows a Store General account, the debit column presenting a record of amounts payable for all stores purchased but not immediately used at

GRAND JOURNAL STATEMENT FOR THE MONTH ENDING ______________ 190__

Line	Date 1903		DR.	CR.	Particulars	Inv. No.	Total Transactions	1 Stores General DR	1 Stores General CR.	2 DR.	2 CR.	3 Bank of Montreal DR.	3 Bank of Montreal CR.	4 Exploration Labor DR.	4 Exploration Supplies Explosives CR.	4 Exploration Supplies Illuminants CR.	4 Exploration Supplies Sundries DR.	5 Ore Production Labor DR.	5 Ore Production Supplies Explosives CR.	5 Ore Production Supplies Illuminants DR.	5 Ore Production Supplies Sundries CR.	6 General Expense DR.
1	*Jan.*	20	10		*Mine Equipment Supplies*	23																
2				3	*To Bank of Montreal*								80									
3					*A.B.Manfg. Co. 1 Mine Ore Car*		80															
4																						
5																						
6	"	31	4		*Exploration Labor*	24								4500								
7					*Shafting* 1,500.00																	
8					*Driving* 1,250.00																	
9					*Raising* 1,000.00																	
10					*Winzing* 750.00																	
11				3	*To Bank of Montreal*								4500									
12					*January, 1903, Payroll*		4500															
13																						
14																						
15																						

GRAND JOURNAL STATEMENT FOR THE MONTH ENDING ______________ 190__

7 Power Plant Labor DR.	7 Power Plant Supplies Fuel DR.	7 Power Plant Supplies Lubricants DR.	7 Power Plant Supplies Drill Fit'gs DR.	7 Power Plant Supplies Sundries DR.	8 Office Expenses DR.	9 Ore Sorting and Tramming to Ry. Labor DR.	9 Ore Sorting and Tramming to Ry. Supplies DR.	10 Mine Equipment Labor DR.	10 Mine Equipment Supplies DR.	11 Mine General Labor DR.	11 Mine General Supplies DR.	12 Mine Machinery Machinery DR.	12 Mine Machinery Freight and Duty DR.	12 Mine Machinery Installation Labor DR.	12 Mine Machinery Installation Material DR.	13 Surface Improvements Labor DR.	13 Surface Improvements Material DR.	Distribution Charged to Exploration	Distribution Charged to Ore Production	Distribution Carried as Asset	Line
									80 00											80	1
																					2
																					3
																					4
																					5
																					6
																		1 500			7
																		1 250			8
																		1 000			9
																		750			10
																					11
																					12
																					13
																					14
																					15

10. GRAND JOURNAL, OR VOUCHER RECORD BOOK.

Upper half shows left-hand side, lower half right-hand side. Column headings and rulings only are indicated. The original is 18 inches high and each page is 22 inches wide.

the mine, and the credit column showing amounts debited other accounts for stores issued for use. No. 2 is left blank in the example for illustration of a provision for any unusual expenditure, such as may occur once now and again, of a nature not requiring the permanent setting apart of a column for that particular class of outlay. The Bank column (No. 3) has Dr. and Cr. subdivisions, but the former does not appear to be much used in this book. The latter contains a record of the amounts of all checks drawn on the bank in payment for labor, supplies, etc., such credits constituting compensating entries to those debiting the various accounts charged with these expenditures. If all transactions with the bank be passed through the cash journal this division might be headed "Accounts Payable." Columns No. 4 and 5, Exploration and Ore Production, respectively, are each subdivided into Labor and Supplies, and the latter further subdivided into Explosives. Illuminants, and Sundries. Ledger accounts are opened for all these sub-heads; for instance, the former has accounts as follows: Exploration, Labor; Exploration, Explosives; Exploration, Illuminants, and Exploration, Sundries, and the latter similar accounts under the general heading Ore Production, each, of course, having its distinguishing classification. These several accounts are debited every month with their total charges for that month, and, unlike the case of Power Plant and some other accounts, the totals of amounts so charged remain as ledger balances until the end of the year or other financial period. No. 6, General Expense; No. 8, Office Expenses; No. 10, Mine Equipment (a) Labor (b) Supplies; No. 11, Mine General (a) Labor (b) Supplies, are all first debited with their respective charges for the month; then entries are made in the ordinary journal crediting these accounts and debiting the respective Exploration and Ore Production accounts which have been opened under these headings in the ledger. The proportions charged to these latter accounts are governed by the number of "miner shifts" worked during the month at exploration and ore production, respectively. For example, if General Expense account (Division No. 6) has been debited with $500 this amount is dealt with at the end of the month by entry in the ordinary journal. Where say 50 miners have each been employed one shift on 30 days of a month a total of 1,500 miner shifts is obtained. Of these 900 have been on exploration work and 600 on ore production, which gives a proportion of 3/5 to the former and 2/5 to the latter, or $300 chargeable to General Expense, Exploration, and $200 to General Expense, Ore Production. The entry in the ordinary journal would therefore be as follows:

General Expense, Exploration........	(Dr.)	$300.00	
General Expense, Ore Production.....	(Dr.)	$200.00	
To General Expense	(Cr.)		$500.00

General Expense account is thus closed for that month and the two accounts to which its debit balance has been transferred after subdivision remain open until the end of the financial period.

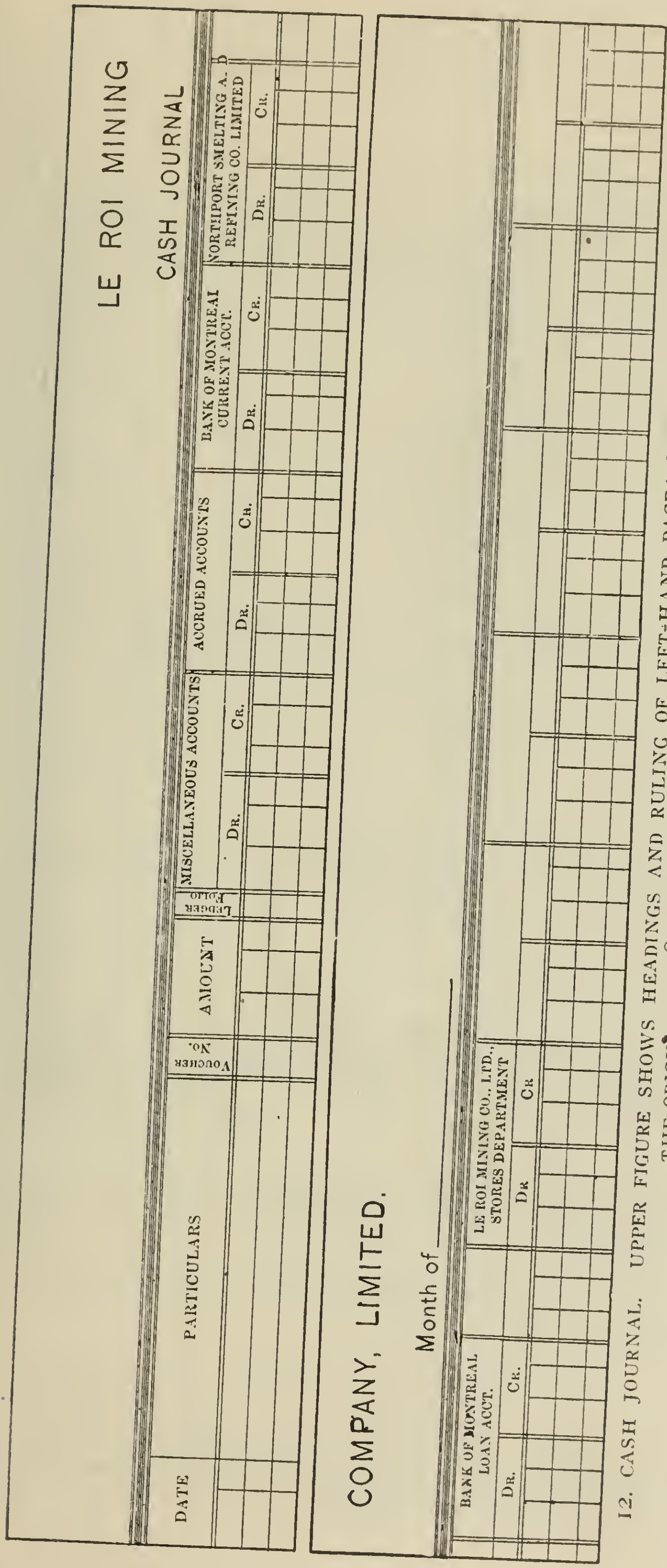
Power Plant accounts are disposed of similarly to General Expense, except that the number of "drill shifts," i. e., the total number of full shifts during which the machine drills in use have been worked during the month, rather than that of the miner shifts, determines the proportion of the distribution between the Exploration and Ore Production accounts. Power Plant, Labor, is sub-divided into Power Plant Exploration, Labor, and Power Plant Ore Production, Labor, whilst the four sub-divisions of Power Plant, Supplies—viz., Fuel, Lubricants, Drill Fittings, and Sundries—are similarly closed into Power Plant, Exploration, Supplies, and Power Plant, Ore Production, Supplies, these accounts also remaining open until the end of the financial period.

No. 9, Ore Sorting and Tramming to Railway (a) Labor (b) Supplies, are purely Ore Production accounts, the amounts debited to them being direct charges on account of Ore Production, and these remain open as well.

Mine Machinery, No. 12, is sub-divided into four accounts, which at the end of the year are all closed into Mine Machinery and Plant account.

Surface Improvements, No. 13, is divided into (a) Labor (b) Material, and these accounts are at the end of the financial period closed into Surface Improvements and Buildings account. They include all surface improvements of every description, such as buildings, ore bins, dump cribbings, gallows frames and other headworks, railway tracks for ore-shipping, water tanks, etc.

The unnumbered division "Distribution" contains three columns, to one or other of which all amounts appearing in the numbered columns are carried. The totals of Exploration and Ore Production columns of this division serve as a check on the Exploration and Ore Production charges for the month appearing in the other columns. The Asset column represents all amounts charged to accounts in divisions 12 and 13, together with sundry items of mine equipment supplies, such as ore cars, skips, machine drills, etc., which from their comparatively long working life are generally treated as assets whilst in working order.



12. CASH JOURNAL. UPPER FIGURE SHOWS HEADINGS AND RULING OF LEFT-HAND PAGE; LOWER FIGURE, RIGHT-HAND PAGE. THE ORIGINAL IS 18 INCHES HIGH AND ABOUT 40 INCHES WIDE.

The double-entry principle of the grand journal is illustrated by the specimen entries appearing in Example No. 10. That this is so is evident from the fact that the Bank of Montreal (Division 3) there shows creditor $4,580, whilst Exploration, Labor (Division 4) appears Dr. $4,500 and Mine Equipment, Supplies, (Division 10) is Dr. $80.—together $4,580, these constituting the double entry and agreeing with Total Transactions, $4,580 and also with the total of the columns of the division Distribution, viz., Exploration, $4,500 and Asset, $80.

The particular use of the book, stores journal, previously referred to as subsidiary to the grand journal, is to record all charges in and out for stores or supplies. It is sub-divided in part similarly to the

EXPLORATION				STOPING		
LABOR	TOTAL COST	COST PER FOOT	CARRIED AS ASSET	LABOR	TOTAL COST	COST PER TON
Shafting				Breaking Ore		
Driving				Shovelling		
Raising				Timbering		
Cross-cutting				Timber Repairs		
Station Cutting				Carmen		
Winzing						
Timbering						
Totals				Totals		
SUPPLIES				SUPPLIES		
Explosives				Explosives		
Illuminants				Illuminants		
Tools				Tools		
Timbers				Timbers		
Lagging				Lagging		
Timber Tools				Timber Tools		
Lumber				Lumber		
Totals				Totals		

POWER PLANT					MINE GENERAL				
LABOR	TOTAL COST	COST PER TON	CH'GD TO EXPLOR	CH'GD TO STOPING	LABOR	TOTAL COST	COST PER TON	CH'GD TO EXPLOR	CH'GD TO STOPING
Mechanics					Foreman				
Comp. Engineers					Blacksmiths				
Hoist Engineers					Mechanics				
Electric Engineers					Powdermen				
Pump Men					Nippers				
Firemen					Tenders				
Repairmen					Surveyors				
Laborers					Laborers				
Totals					Totals				
SUPPLIES					SUPPLIES				
Fuel					Iron and Steel				
Lubricants					Smith's Coal				
Drill Fittings					Illuminants				
Pipe Fittings									
Iron and Steel									
Electric Power									
Totals					Totals				

RESULTS OF OPERATING MINE

EXPLORATION					STOPING				
PLACE	FEET ADV'ED	‡TOTAL LENGTH	NO. TONS ORE	NO. CARS WASTE	PLACE	SQ. FT. WALL EXP.	TONS PER SQ. FT.	NO. TONS ORE	NO. CARS WASTE
Ft. Level					Ft. Level				
Ft. Level					Ft. Level				
Totals					Totals				

EXTENT OF ORE SHOOTS OPENED AND ORE SHOOTS STOPED

Foot-wall Area of Ore Shoots Blocked Out by Exploration Work During Month	Sq. Ft.	To Date	Sq. Ft.
Foot-wall Area of Ore Shoots Stoped During Month Amounts to	Sq. Ft.	"	Sq. Ft.
Ore Extracted per Square Foot-wall Area During Month Amounts to	Tons	"	Ton

‡ Drifts are measured from centre of shaft. Raises from top of level below. Cross-cuts from side of drifts, and Stations from side of shaft.

Rossland B. C., ______ 190__

II. MONTHLY SUMMARY OF DETAILS OF INFORMATION. LEFT-HAND SIDE.

The form is so large that it is necessarily somewhat condensed by leaving out blank and duplicate spaces—as in the spaces for the various levels, lower left corner. The other half is shown opposite.

ORE SORTING AND TRAMMING TO RAILWAY				
LABOR	TOTAL COST		Cost per Ton Shipped	
Foreman				
Crushermen				
Ore Sorters				
Samplers				
Trammers to Waste Dump				
Ariel Tram Runners				
Mechanics				
Laborers				
Totals				
SUPPLIES				
Tools				
Oil				
Lumber and Nails				
Illuminants				
Carpenter Work				
Smith Work				
Totals				

MINE EQUIPMENT								
LABOR	TOTAL COST		CH'GD TO EXPLOR.		CH'GD TO STOPING		CARRIED AS ASSET	
Trackman								
Pipemen								
Carpenters								
Machinists								
Blacksmiths								
Laborers								
Totals								
SUPPLIES								
Ore Cars								
Machine Drills								
Rails								
Columns								
Stoping Bars								
Lumber								
Pipe								
Pipe Fittings								
Electric Wires								

ORE RECORD	
Crude Ore Hoisted	Tons
First Class Ore Delivered to Smelter	Tons
Second Class Ore Delivered to Smelter	Tons
Waste Delivered to Dump	Tons
Cost per Ton First Class Ore Delivered on Railroad Cars	
Cost per Ton Including all Mine Expenditure	

CARRIED AS ASSET						
MINE MACHINERY LABOR	APPENDIX A					
Installing						
MINE MACHINERY SUPPLIES						
Installing						
SURFACE IMPROVEMENTS LABOR	APPENDIX B					
Installing						
SURFACE IMPROVEMENTS SUPPLIES						
Installing						
MINE EQUIPMENT						
Carried as Asset						
Charged to Exploration						
EXPLORATION						
POWER PLANT						
MINE GENERAL						
GENERAL EXPENSE	APPENDIX C					
SUPPLIES ON HAND						
Totals						

RECAPITULATION								
OPERATING EXPENSES								
STOPING								
Labor								
Supplies								
POWER PLANT								
Labor								
Supplies								
MINE GENERAL								
Labor								
Supplies								
ORE SORTING & TRAMMING TO RY.								
Labor								
Supplies								
MINE EQUIPMENT								
Labor								
Supplies								
GENERAL EXPENSE	APPENDIX D							
Manager's Office								
Mines Office								
Assay Office								
Contingencies								
Charities								
Totals								

EXPENDITURES CARRIED AS ASSET						
Mine Machinery						
Ore Sorting Machinery						
Surface Improvements						
Mine Equipment						
Exploration						
Power Plant						
Mine General						
General Expense						
Supplies on Hand						
GRAND TOTAL ALL EXPENDITURES						

____________________ *General Manager*

II. MONTHLY SUMMARY OF DETAILS OF INFORMATION. RIGHT-HAND SIDE.

As in the case of the other half, shown on the facing page, the form is slightly condensed as well as reduced in size. The entire original form is 21 inches wide and 18 inches high.

grand journal, omitting all columns for record of labor charges. Its first debit column starts with the amount or cost value of all supplies on hand at the beginning of the month, and to this are added all purchases during the month. Its credit column contains all credits to Stores General for stores issued during the month, the distribution of these amounts appearing on a voucher, particulars of which are entered in the grand journal, through which they are debited to their various supply and material accounts. The excess of the total of the first debit column of the stores journal over that of the credit column represents the value of the stores on hand at the end of the month, and this amount is carried forward as the first debit in the new month.

The grand journal footings of divisions 1 to 13, both inclusive, are posted monthly to the ledger. At the end of the financial period all ledger Exploration accounts are closed into Mine Exploration and Development account, and all Ore Production accounts into Profit and Loss, or are otherwise dealt with as the management shall direct.

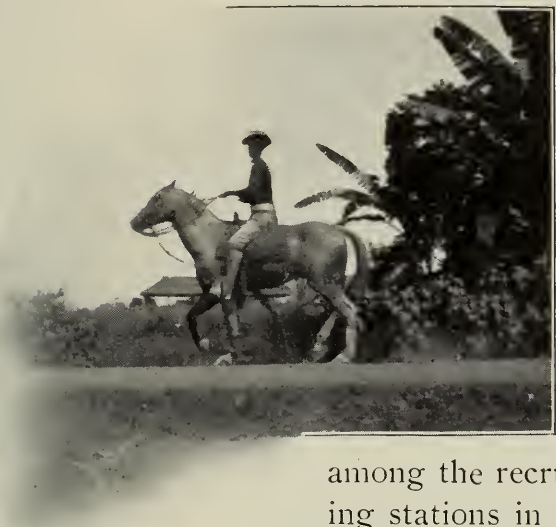
The sheet exhibiting details of mining operations, Example No. 11, gives a monthly summary of all information, relative to expenditures for labor and supplies during the period under review, obtainable from the grand journal and other sources; also costs per foot of development and per ton of ore produced. In connection with Exploration (or Development), it shows the number of feet of advance made during the month in each part of the mine in which men have been employed, and the total footage to date accomplished in each working, together with tonnage of ore and waste, respectively, taken from each working during the month. In connection with Ore Production or Stoping it furnishes information relative to the tonnage of ore and waste handled, tonnage of ore per square foot stoped, tonnage delivered to smelter, and costs per ton. It also shows what proportion of expenditure is being carried as an asset, giving, where necessary, particulars in appendices, and states separately the expenditures charged to capital and labor, respectively. Further, it gives extent of ore shoots opened up and those stoped, and altogether supplies to the head office, under the signature of the manager, much information in compact form and clearly stated.

Whilst it is scarcely expected that the foregoing descriptive matter, together with the accompanying examples of book rulings and headings and of forms in use, will enable a novice to carry out a similar system without more particular instruction, it is hoped that to those familiar with account keeping it will be sufficiently clear to enable them to grasp its principles and appreciate its merits.

TELEGRAPH ENGINEERING IN MORO LAND.

By a Member of the Corps.

The writer of this article is serving with the signal corps of the American forces in Mindanao, but prefers that his name should not appear.—The Editor.



THERE is a class of men in the army of whom one seldom hears much, but who are of essential value to any undertaking of the Government in a new land. I refer to the members of the signal corps. It may be interesting to note some of the characteristics of the life of the signal-corps man in Moro land. In the first place, he is selected from among the recruits offering themselves at the enlisting stations in America, or from among the organized troops in the islands. The inducements for young men to enlist in the army as telegraphers are not so very great, yet the first-class sergeants of the corps receive practically almost as much pay as second lieutenants of the line, when rations, clothing, etc., are taken into consideration. It is by no means uncommon now-a-days for the privates of the corps to work their way up and eventually secure commissions. Still, the advantages and privileges do not tempt the bright young men of the telegraph fraternity to the extent desired by the officers, with the result that in most stations men are detailed from the troops to assist. In the Moro campaign of 1902 it was necessary to secure a number of experienced men from the companies to aid the corps. In an army one can find all sorts of men, and in every regiment there are always two or three men who were formerly telegraph operators, machinists, engineers, teachers, lawyers, and the like, representing all trades and professions. The material available for the signal corps therefore is good. Often the man transfers from the organization to which he belongs to the corps.

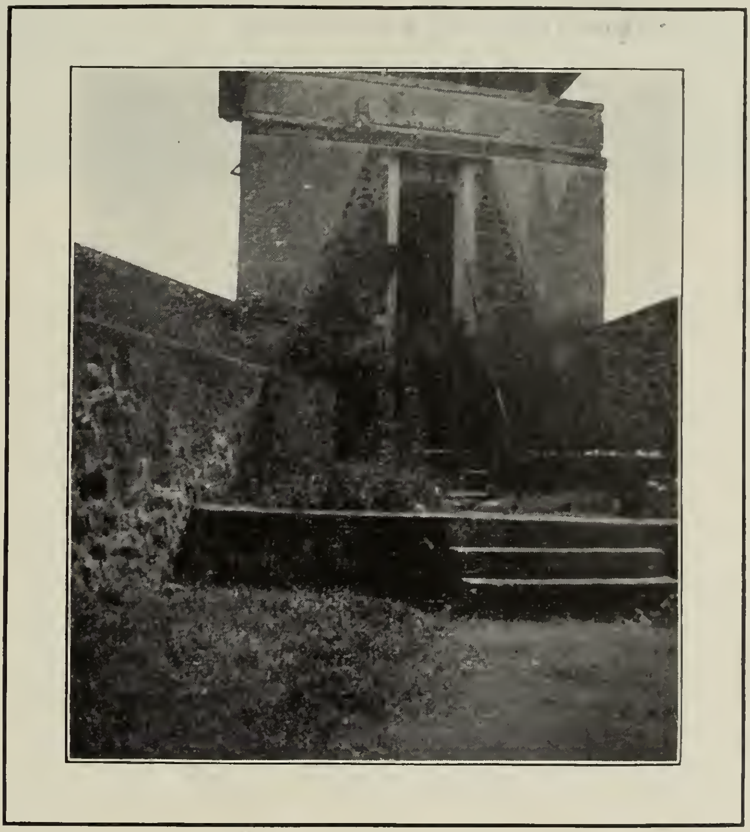
In the field it was our practice to throw up a fly, canvas, or sometimes only a shelter-half, and under this place the instrument and get to work sending and delivering messages with the wire on the ground. If possible, gangs of natives were secured and light poles put up to string the wires. If permanency of the camp were assured,

THE EXTERIOR OF TOWER TELEGRAPH OFFICE IN AN OLD FORT.

TELEGRAPH OFFICE IN AN OLD SPANISH FORT.

then the corps would undertake to establish a good line on cocoanut or other strong poles. But in garrison, one has only to look for a cosy nook in one of the Spanish forts and here he finds not only excellent quarters for office work but a good place to sleep in.

The Spanish took every precaution to protect their telegraph and signal towers, and usually employed one of the corner or end towers of the fort for the purpose. There is no possible means for entering at the front or sides, because it is all solid masonry. The rear door is about twenty-five feet above the ground and is reached by steps. These steps can be hauled up for protection. There are several port



THE GUARDED ENTRANCE.

holes in the tower, and as the signal men are properly armed, a good resistance could be made in the event of a Moro attack.

The signal corps could hardly get along without native helpers to do the heavy laboring and line work in Moro land. The Moros do not take to work, and the signal sergeant or corporal has to use considerable tact to hold his gang together for purposes of working. The natives have many *festa* days, and the first thing you know all hands lay off a day and you may threaten and coax and they will not return to work. I have had operations stop on a raft in the middle of a stream, because these fellows quit work for some pretense. If a child is slightly ill at home, if the wife scratches her finger, if the man him-

FIELD MESS TENT AND LAUNDRY.

self is very slightly indisposed, or any little thing occurs to disturb the harmony of the usual run of things, the lazy Moro finds in it ample excuse not to work that day. While they do work, these agile natives are handy. They can go up a pole without spikes very quickly, and if you stand under and make them do so, they will connect up the wire well. They will put on an insulator correctly, if you watch them. But you must watch them very closely, otherwise they will be very slipshod and the work will fall to pieces quickly.

Signal corps men in the States and in settled sections of the islands are not as a rule mounted. But here in the land of the Moros, where there is occasional activity, no one cares very much if you own and ride a horse. I purchased a native pony for $12 gold. I got a saddler of one of the cavalry troops to make a bridle for $2, the quartermaster let

SUPPLIES GOING TO THE FRONT. THE HOUSES ON THE LEFT ARE THE SHACKS OF NATIVE HELPERS.

me have a condemned saddle, and I am fitted out in good form and can use the tough little beast to go anywhere. I let him run with the other horses and he fares well. Some of the corps are temporarily mounted on American horses.

I have letters at hand from friends in the fraternity at home inquiring about our method of living. We usually club together and hire a

A FIELD REPAIR SHOP.

native or a Chinese cook, and with the ration which is issued us, consisting of coffee, pepper, salt, vinegar, flour or bread, some canned meats, tomatoes, pickles, etc., we can get up a good mess, especially as we have access to the sales commissary where it is possible to buy the best kinds of canned fruits and the like. It costs us about 28 cents per day each for the mess. This covers cigars, etc., and the expense of entertaining members of the corps passing through. We do not have to wash our clothes, as a friend asks; the laundry is done by one of the troop soldiers detailed for the purpose, who charges us one dollar per month, and in turn uses the money to pay native washermen, and buy starch, blueing, soap, etc. He makes a slight profit on the enterprise.

Probably the signal men are bothered more in this new Moro land about supplies and means of making repairs than any of the men in the older sections or more settled posts. Down here in far southern Zamboango, Malabang, Cottobatto, and Parang, we are quite away from the other places. Often as much time expires in getting mail and supplies for the signal corps from Manila to us here, as from San Francisco to Manila. The result is that considerable ingenuity is re-

WHERE SOME BRAVE MEN LIE.

quired on the part of the men who possess a mechanical turn. Nearly all have been trained in mechanics and understand metals and mechanisms, and in the event of some part breaking or wearing, are usually able to replace the part with one shaped by hand or repaired with patching. Usually a tent is put up and a rough bench installed, and here the tools and fittings of the corps are placed in readiness.

The signal men have three or four classes of enemies of the wires to deal with. First there are the ladrone Moros, who chop out sections of the line for the sake of the wire for mechanical use on their farms. Then there are the foes who cut down poles and fell trees across the wires and the like to cut off communication and you have to travel out in the rains or the night with a small guard and half a dozen linemen to repair the break. Then the white ants are a bother, for they eat the woodwork of the poles in places in a few months and the pole topples over. Then there are the gales that sweep débris on the wires and stop operations. Earthquakes have occurred twice in the past year with such violence that the wires have been wrecked along mountain sides by landslides. It is hard work for the non-commissioned officers and the privates of the corps, as well as for the commissioned officers; but all work well together and with a will that is astonishing. The result is that communication is maintained between all these posts in the southern portion of Mindanao, about the seat of the recent Moro troubles of Lake Lanoa.

FOUNDRY MANAGEMENT IN THE NEW CENTURY.

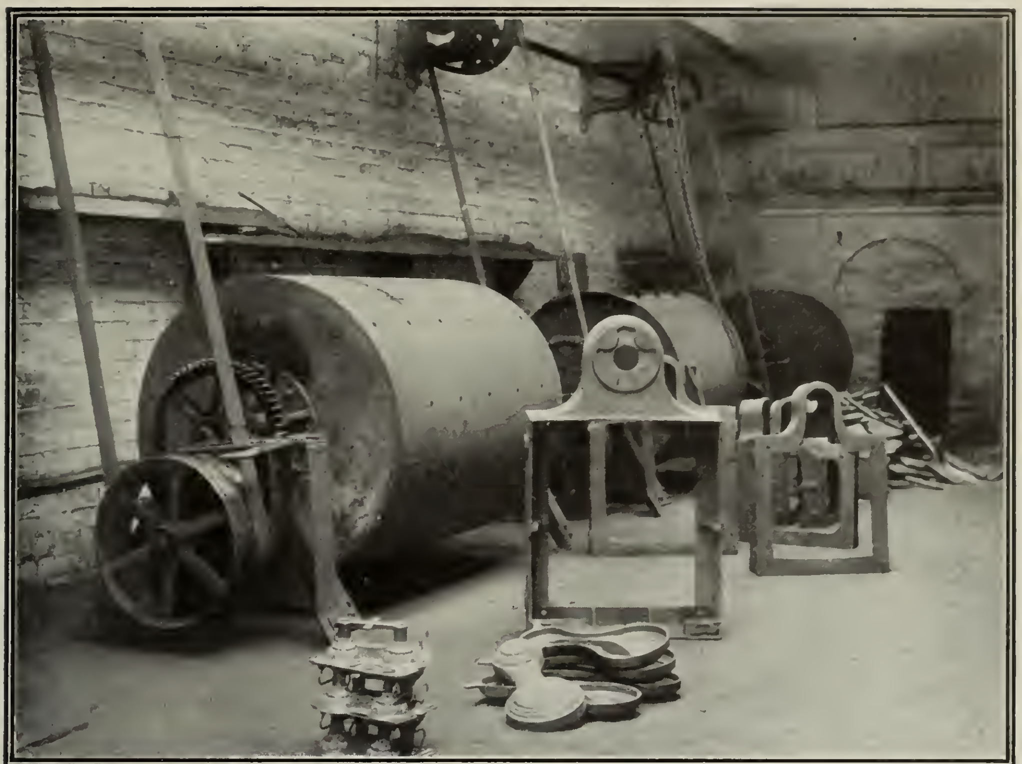
By Robert Buchanan.

VI.—THE DRESSING OF CASTINGS.

Mr. Buchanan's first article appeared in our issue for December, and dealt with the general arrangement of the foundry, heating and ventilation, and the supply of tools and minor plant. His second paper discussed crane service for the foundry floor; his third, moulding by hand and machine. The fourth paper took up the specification and purchase of supplies, and the fifth dealt with the management of the cupola. The concluding article, which will appear next month, will review the "Qualities and Training of the Foundry Manager."—THE EDITORS.

IN fettling or dressing castings the tumbling barrel, or "rattler" as it is sometimes called, has an important part to play. Whether it be octagonal or round in cross section is much a matter of indifference, though the octagonal barrel may in some degree tend to increase the movement of the castings during the process of tumbling. Octagonal barrels are usually made of cast iron. The circular or cylindrical barrel is almost always of wrought iron or steel plates. As almost everyone is aware, the castings as they come from the foundry are put into these barrels, and for a number of hours more or less are tumbled or "rattled" together, with some material which is put into the barrels along with the castings, so as to increase the action on the surface of the castings. It is not uncommon for barrels made of wrought iron or steel plates to have the heads of the rivets protruding inside the barrel, with the result that the castings soon wear them away sufficiently to allow the remaining parts of the rivet heads to be drawn through the plates, and so the barrel readily comes to pieces. All rivets or bolt heads should be flush with the inside of the plate, and if that is not possible owing to the thinness of the plate, then such projecting heads ought to be covered by means of a casting which is itself held in place by bolts which are flush. Shafts ought not to pass through the length of the barrel from end to end, as they hinder in a very considerable degree the filling and emptying of the barrels. As everyone is aware considerable dust is formed during the course of tumbling. To have the quickest and best results, this dust must find its way out of the barrel. If the barrel be so tight as to retain the dust, the latter acts as a kind of lubricant between one casting and another, retards the smoothing effect of the tumbling, and renders necessary considerable brushing of the castings to make them presentable when got out of the barrel. In many cases the dust is withdrawn through a hollow shaft on one end of the barrel, the exhaustion being accomplished by means of a suitable fan. This leaves the castings in the best condition for smoothing one another. In Europe such a system of exhausting the dust is not at all common, and so the building in which the barrels are situated is probably the most unhealthy part of the foundry. It is hardly too much to say that tumbling barrels not fitted with a system of exhaust ought to be forbidden by law.

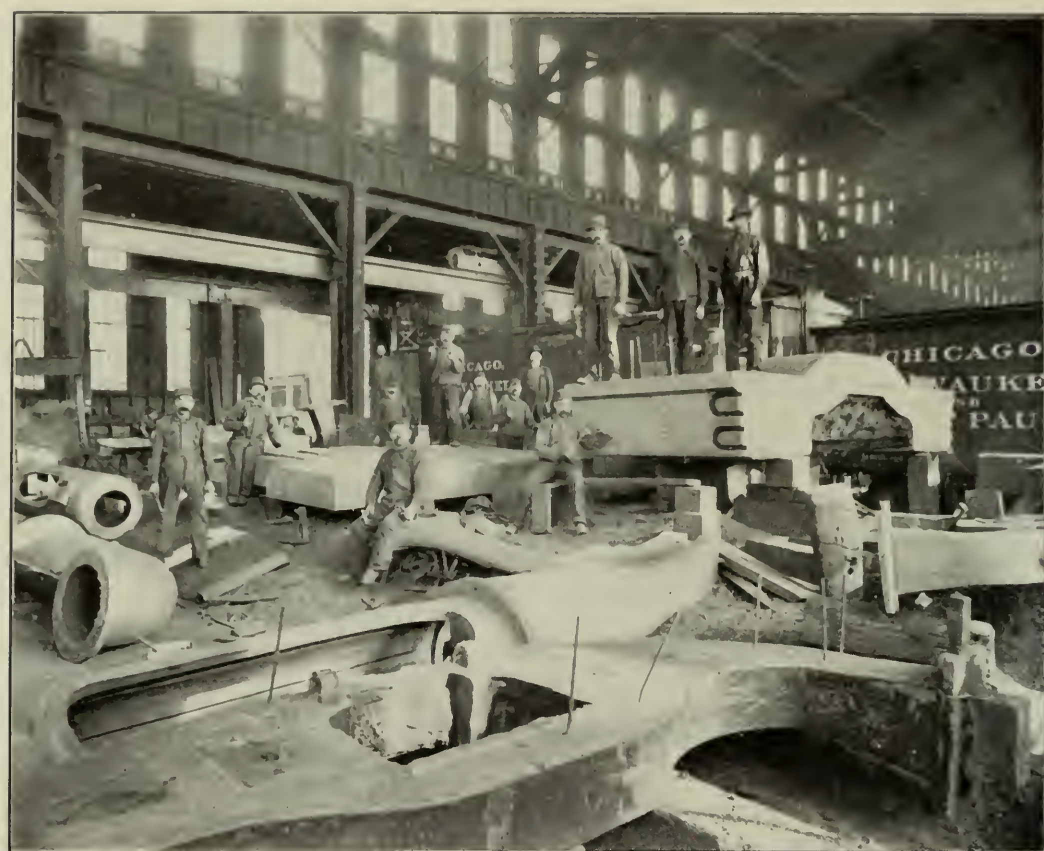
As regards the size and class of castings which may be tumbled, this is largely a matter for judgment by the foundrymen. On the one hand, castings may be slender and fragile, or have delicate figuring on the surface which will be blunted and defaced by the tumbling, or, on the other hand, castings may be so large that the tumbling either breaks them or they break other castings which may be along with them. Castings as nearly alike as possible in size and character should be put into each barrel. The size of casting which may be profitably tumbled is limited only by the size of the barrels and facilities for handling the castings. Foundries mostly use one of three things as the material to be charged into the barrels, along with the castings. These are stars of chilled cast iron, "gits" off the castings themselves, or slag from the cupola. Of these, the gits are probably the best to use; being constantly produced, they may be renewed as often as necessary, and the tumbling cleans them from adhering sand, making them in still better condition for melting in the cupola. The stars are excellent for tumbling purposes, but cost money to produce. Slag from the cupola is often used, costing nothing but the labour of bringing it to the barrels; but it has the great disadvantage of causing excessive quantities of dust. It has an advantage over the stars or the gits inasmuch as it does not so readily find out the "kishy" or spongy parts of the castings. If using stars or gits greater attention has to be devoted to the gating of the castings, so that they may be clean and sound, if the discovery of more than a moderate percentage of waster castings by means of the tumbling is to be avoided. The number of castings broken in the course of tumbling gives an excellent indication of whether the mixing of iron at the cupola is right or no. A large breakage of castings may be laid to the account of bad mixing or bad melting, or both, rather than to back packing of castings in the barrels.



CORNER IN THE TUMBLING-BARREL ROOM OF THE SOHO FOUNDRY, BIRMINGHAM, ENGLAND.

The nearest barrel is 4 feet in diameter; in it are tumbled castings each weighing 250 pounds. Each casting is subjected to a series of more than 5,000 shocks. Breakages are practically unknown.

In 1896 A. E. Outerbridge brought to the notice of foundrymen the results of a series of observations regarding the effect tumbling has upon castings. These observations were amply confirmed by a committee of the Franklin Institute. It is hardly too much to say that within the last ten years, no matter of greater importance has been submitted to the notice of makers and users of castings. Every foundryman is aware that castings in the course of cooling are subject to various strains, strains which sometimes result in fracture. Outerbridge has shown that such strains exist in every casting, no matter how simple the form. Even test bars subjected to tumbling gave results 10 to 15 per cent. higher than those not so treated. In the experiments by the committee of the Franklin Institute some of the tumbled bars were increased in strength by 35 to 40 per cent. The idea is that the strains due to cooling are dissipated or distributed by the repeated knocks and shocks encountered in the course of tumbling, and that such dissipation takes place exactly in the same degree as the shocks are in number and force. Such an effect is, however, modified in some degree by the quality of the iron itself, as



DEPARTMENT FOR CLEANING HEAVY CASTINGS, ALLIS-CHALMERS SOUTH FOUNDRY.

regards hardness and softness. Hard or strong irons exhibit the highest results, soft irons the lowest. This is what one might expect, as hard irons are subject to greater cooling strains. The effect of tumbling is thus in some degree similar to that obtained by annealing, but in the latter case certain changes of chemical composition (and particularly of the carbon) take place, which do not obtain when tumbling is resorted to. Outerbridge also discovered that castings which would break if subjected to blows of a certain force at the beginning would withstand these successfully if applied after being led up to with a series of blows gradually increasing in force. He contends that the dissipation of the cooling strains by a series of shocks such as tumbling gives is due to the vibration of the molecules allowing or aiding them to take up a new relationship to one another.

Professor Ledebur thinks that the change which results in making tumbled castings stronger is due to the shock acting upon the skin of the casting which has got into tension during the process of cooling. That a certain stretching of the skin of the casting, due to impact takes place during tumbling, is very possible. It is probable, however, that this is a subsidiary cause; that the rearrangement of the molecules is the primary cause is more probable still. Whether the strengthening of castings by tumbling be due to the stretching of the skin as suggested by Professor Ledebur, or to the rearrangement of the molecules as maintained by Outerbridge, it is scarcely possible to exaggerate the immense importance to foundrymen of the fact itself.

As castings may fracture at the beginning of barreling from shock which they otherwise would have withstood successfully later, it is a simple deduction that the castings should have small shock and movement to begin with. How is that to be accomplished? Barrels should have two speeds, a fast and a slow. Start with the fast and finish with the slow speed. The shock is greater with a slow speed, as the castings have time to fall through a greater distance.

The use of the sand blast with a view to improving the appearance of the castings by making them smoother has been doubtfully successful. Sand blast may be useful in getting the scale off steel castings, which have been subjected to annealing in an oxidising

"SCRATCH ROOM" AT SOUTH FOUNDRY OF THE ALLIS-CHALMERS COMPANY.

atmosphere, but steel castings do not usually occupy the position of being exemplars of what the skin of a casting ought to be. The sand blast may clear the surface of iron castings of carbon and siliceous matter with a view to substituting on such surface some other metal or material, but it will not smooth the surface of rough castings. The stream of sand projected against the casting bites into the surface at the same rate all over such surface, and as the body of the casting is worn away at the same rate as the projecting roughness the result is unsatisfactory. Sand blasting may actually make rougher a casting which was previously smooth. Thus it is my experience that unless for special and specific purposes, sand blasting is of little use to the ordinary iron founder.

SAND-BLAST MAN READY TO PUT THE BLAST ON, SCHENECTADY SHOPS OF THE GENERAL ELECTRIC COMPANY.

Castings to be used for engineering purposes, and upon which much machining has to be done, are often dipped into dilute acids so that the silicates formed on the surface of the castings may be dissolved, and so less readily blunt the tools with which the machining is done. The dilute acid also dissolves the combined carbon on the surface of the casting. It does not dissolve the graphitic carbon. Sulphuric acid and hydrofluoric acid are used, the former being most in use, but it has considerable effect upon the iron itself. Hydrofluoric acid attacks the silicates and has less effect upon the iron itself, but is more expensive than the other. When using sulphuric acid the dilute acid is contained in a wood trough with lead lining. The castings are packed into a wood box, with perforated bottom, the straps holding the box in shape and by which it is suspended being of copper fastened with copper rivets. The box containing the castings is lowered into the dilute acid, when vigorous boiling takes place if sand has been left in the core holes. After an immersion of about twenty minutes the box containing the castings is hoisted up, allowed to drain back into the trough containing the acid, and is thereafter swung aside and drenched with plenty of clean water. Such a course of treatment, however, is advisable only where machining has to be done. It is detrimental to castings which have to be sold largely by their appearance, as the acid sets up a vigorous oxidation or rusting, which detracts very much from the appearance of the castings.

CLEANING CASTINGS WITH ELECTRIC-DRIVEN EMERY GRINDER IN THE BROWN & SHARPE SHOPS.
The grinder is driven through flexible shaft; Stow Manufacturing Co., Binghamton.

When fettling or dressing castings abrasive wheels play an important part. These consisted, until recent years, of emery or corundum or mixtures of these. Within the past few years to these has been added a formidable rival in carborundum. Emery and corundum are natural products; carborundum is a manufactured article, produced by means of the electric furnace, being manufactured by the Carborundum Co., of Niagara Falls, N. Y. Emery has less abrasive or grinding power than corundum, and corundum less than carborundum. As corundum has greater cutting powers than emery it was selected for a comparative test with carborundum, the latter costing 12 shillings more than a corundum wheel of similar size. On two grinding machines of similar size and speed driven from the same shaft there was put on one a corundum wheel 20 inches diameter by 2 inches thick, and on the other machine, a carborundum wheel of similar size. The wheels were run at a speed of 950 revolutions per minute. One man worked day about on each wheel, fettling exactly the same class of castings. The corundum wheel lost 4½ inches of

CARBORUNDUM WHEELS IN GRINDING ROOM OF THE WHITINSVILLE MACHINE WORKS, CAST-IRON DEPARTMENT.

diameter in 27½ working days, and fettled 46 tons of castings in that time. It was then taken off and a wheel made of a mixture of corundum and emery was put on in its place and worked for alternate days, as before stated. This wheel lost 3½ inches of diameter in 11 working days having fettled 19 tons of castings. The corundum and

CLEANING CASTINGS WITH ABRASIVE WHEEL DRIVEN BY STOW FLEXIBLE SHAFTING.

Stow Flexible Shaft Co., Philadelphia.

emery wheel was a faster worker than the wheel made of corundum only, but as will be seen wore away very much faster. To come now to the carborundum wheel, which was a faster worker than either. At the end of 157 working days it had lost 3½ inches in diameter and 14 pounds in weight. During that time it fettled 259 tons of castings. That is a wonderful record. Carborundum wheels do not glaze, and keep a cutting surface from first to last.

CARBORUNDUM WHEELS AT WORK ON CHILLED IRON PLOUGH POINTS.
Syracuse Chilled Plough Company.

Pneumatic chipping tools have obtained considerable attention in recent years. That they are suited for chipping heavy castings made in dry sand or loam there is no doubt, but they are not so successful on all classes of work. They are not suited for chipping light "fins" or "flash" as the tool readily jumps unless there is a good resistance in front. The adoption of the pneumatic chipper is often difficult owing to the foundry yard where large castings are fettled or dressed being in many cases at a distance from the available power. When this difficulty is overcome by the conveyance of compressed air to the tool they may be profitably used for heavy chipping. In calculating the advantages obtained from the use of these tools it is well, however, to remember that the power necessary to actuate these tools is rather considerable. Each of them absorbs from 1½ to 2 horse power.

Files.—When a foundry is in close business relations with the branch of engineering where the castings are fitted up, a profitable arrangement for both may be made by which the foundry dressers use up the files first used by the engineers, or machinists, as they are called in America. When engineers are on day work they may not be so particular about using a half-worn file, but piece workers demand newly cut files and plenty of them. It pays to give them these, especially if another class of workers, such as dressers, can utilise the files, which for their purpose are as good as new ones. In one works the adoption of this system resulted in a saving of nearly £100 per annum in files for dressers' use. To carry out this arrangement successfully there must be some common sense used. The engineers are not to have such difficulty in getting files exchanged that to prove they are past work they previously give them a few rubs on the hardened jaws of a vise. Neither should they be forced to work them until the files are so smooth that no man, be he engineer or dresser, can profitably work them, for this makes the transfer from engineer to dresser merely an added waste of time. Let the engineer leave the files with some work still in them; the dressers will soon make them smooth enough.

Inspection of Castings.—Where moulders are paid by piece work, the inspection of castings becomes an important matter and the results are often such as do not tend to make the inspector a popular personage. Popularity with the men could readily be obtained, but the inspector would probably get into trouble elsewhere. Where the standard of quality of castings is high, differences of opinion as to whether castings should or should not be rejected more readily arise, and it is well that the manager, or superintendent of the foundry, should consider himself as a "Court of Appeal" should sharply marked differences of opinion prevail. The knowledge that the manager or superintendent of the foundry not only permits but invites such appeals to him tends to prevent these differences taking an acute form, and at the same time provides against bias being unjustly exercised for or against any man. The bribing of inspectors so that they shall pass doubtful work is not unknown, but when the manager takes a close interest in the inspection and rejection of castings the giving or taking of bribes becomes a very dangerous course to pursue. The foundry manager ought to visit the scrap heap to view the waster castings every day, and early in the day. It is the waster castings that need looking after; the good castings look after themselves.

When waster castings are produced, say by faulty cores or dull iron, either of which may not be due to the moulder, it is sometimes a cause of trouble when the moulder is made to stand the loss of the castings. This may occasionally be a hardship, but the general good demands its enforcement. No management worthy of the name will ask the moulders to use bad cores, or cast with unsuitable metal; neither should it allow the moulder to cause losses by using materials which he knows will result in waster castings. When the moulder is aware that he takes all the risks in using doubtful materials, he takes good care that so far as he knows no such risk shall arise, and thus the policy mentioned tends to economical production.

It is advisable to cause each moulder to mark his castings in such a way as to enable their identification, either when immediately produced or afterwards when they are being worked up into finished goods. This may be done either by means of numbers or initials, the latter being the better plan unless the number of hands employed is exceedingly large. The knowledge that at all stages of its progress and at all times a casting may be traced to its producer, causes an amount of care and attention to be devoted to the castings which is obtainable in scarcely any other way. Whether castings be produced on day's wages or on piece-work rates, it is advisable to note daily the number and weight of castings produced by each individual. Neither system of work can produce satisfactory results unless this be done. The idea that his work will slip through unnoticed amidst that of many others is demoralising to any worker, whatever position he occupies. Without individual responsibility results are bound to be unsatisfactory. This system of checking individual output not only has the effect of checking waste of time and bad work, but is also a measure of the value of the better workman. Where piece-work rates are paid when extra work is to be done, involving payments beyond those fixed for the job, a book in which these extra payments are entered should be used, and from this book such extra payments are extracted for invoicing purposes. The use of the "Time allowance" book makes such payments regular in amount, forms a constant record of why and to whom such payments are made, and thus tends to prevent fraud or favouritism between foreman and men.

COST REDUCTION BY THE USE OF THE PREMIUM PLAN.

By C. A. Colwell.

Mr. Colwell's article is a straightforward story of five months' practical, personal experience introducing the premium plan into a large shop. The reductions of time are surprising, and are given in specific detail for standard pieces and operations. The definiteness of the paper makes it especially valuable, and the side lights on successful methods of dealing with men of various temperaments and capacities and of stimulating production throughout the works are very interesting.—The Editors.

THE following article gives a brief record of the results of five months' work in putting the premium system on a firm footing in a works employing about six hundred men in machine, boiler, smith, and erecting shops. The machines are not of the latest pattern; the castings are not of as even a grade as could be desired for a perfect scheme of timing, and worst of all are the "rush express" orders, which must be gotten out; in most cases a man finishes his cut on the piece in his machine and puts in the "rush express." He puts in his best efforts to get rid of it and yet make a job that will pass inspection, so as to get back at his premium work. So much for the material I had to start with. The records will show the immense advantage which the premium system, when properly handled, can secure to both employer and employee.

The time keepers in the departments were young fellows who received 15 to 17½ cents per hour, and their sole duty was to keep accurate time on the work—one in the smith shop, one in the boiler shop, one on the erecting floor. The machines were under my direct supervision. When the times had been gathered and tabulated, the boiler and smith shop were each left under the care of one man; the smith shop has fourteen fires and three steam hammers to be cared for; the boiler shop has three radial drills, one countersunk drill, and four air riveters.

In boiler and smith shops the time was set by the job, except the drilling, which was by the piece; ordinary methods of figuring could hardly be used in these departments, because of the awkward shapes of the pieces.

Now that the limits have been set in nearly all departments, the boiler and smith shops are kept by one man, the erecting and engines and machines by another, and the drills are under a foreman who keeps the time and work to be given for all the drills. The output on the drills has been tripled, and now instead of having huge piles of work accumulated all around the drills, it is a hustle to get work for them, simply because each man is alive to the possibilities of each piece of work, and thinks if he does not make two hours for himself,

Machine No. 66 Operator M Dinklemann Date 10/24

		TIME	PREMIUM
$6-6^{45}$	Sheaves 4745 A (1)	3/4	1/4
6^{45} 10^{45}	" 173613 (9)	4	1 1/2
10^{45} 1^{45}	Hand wheels (6)	3	1
$1^{45}-3$	Bearings (solid) 9019 (3)	1 1/4	
$3-6^{30}$	" " 12887A (3)	3 1/2	

Machine No. 66 Operator O Dinklemann Date 10/30

		TIME	PREMIUM
$6-6^{30}$	pipe flanges face 5	1/3	
6^{30} 11^{30}	" " thread 45 (4")	5	3
$11^{30}-4$	" " " (2") 14		
	" " " (2½") 9	4	1
	" " " (1½") 6		
$4-6^{30}$	sheaves 5455113	2 1/2	

SAMPLE BLANKS AND ENTRIES OF TIME RECORDS.

which also means two hours for the company, he is doing a poor day's work. Some times and pieces will be given later.

There were already in use some blanks on which time was kept; for each machine and each piece of work, some times had been secured and were used as a working basis. From the daily time slips, at the end of each month, were gathered the times—both individual and combined—on the various pieces machined and entered on the piece slips. Records were obtained also from the machine book; it was kept in the same way as the piece slips, with the exception that it was for the machine on which the piece was done, so there were three records—the daily time slips, the piece slips for office use, and the machine book for machine-shop and premium-clerk's use. Where a piece had been timed it was entered in the machine book under the name of the machine on which the work had been done.

The worst difficulty in getting the men to accept the premium system was the fear that if they did go at it in the proper spirit and work the machine to its limit and burn tools occasionally, their limits would be cut, their wages cut, and finally their space become of more value to the company than their services. Indeed, when such results have been obtained as are hereinafter shown, it is but natural for the company to feel that it had been systematically swindled and to seek redress by a cut; yet this is one of the worst possible things any company can do, as the men will pass it very quickly from shop to shop; it is this very cutting by employers which has caused the premium system, piece work, and other bonus plans, to be discouraged by labor unions and all fair-minded workmen.

A trouble which was met as soon as the premium time had begun to get a foothold, was that the day men and night men each complained about the condition in which the other shift left the tools; that was easily settled by a duplicate set of tools for each man and a cupboard to keep his own tools in. The next difficulty was over pieces which took fifteen, twenty, or thirty hours, to complete. If there were several of the same kind, each man had his own piece and worked on it till quitting, and the man on next turn took it out and put his piece in. The pieces were small, that is to say, 6 by 6, 7 by 7, 8 by 8, or 9 by 9 cast-steel crank shafts. But in case the piece could not be removed readily from the machine, the time of working the piece was divided up between the various operations. Taking, for example, the 7 by 7 crank; if only one was to be done, by night and day man, it was divided up in the following way:

Roughing ends to $1/32$ and fitting collars, six hours; roughing and finishing pins and eccentrics, thirteen hours; finishing ends, seven hours. The old time on a 7 by 7 crank was forty hours; the time above—twenty-six hours—is what was set; the work is now being done in twenty, so the operator makes for himself from 2½ to 3½ hours every two days, depending on the quality of steel in the casting.

If the piece in the machine at quitting time is nearly finished, I allow the man the proportion of time he has worked on it irrespective of what the man on next shift does; that is, if the piece is three-fourths or more finished, sometimes for a steady workman, one half is allowed. I find that the night shift never does as well as the day shift. For some reason they do not run at as high a speed or take as heavy a cut; it is just the same if a day man, who has made premium, goes on nights; he seldom gets any premium.

On two 42-inch lathes of the same make, there are two men of different nationalities, strong union men; they would not take premium, and how to get them at it was a puzzle. Seeing them quarreling one day, I used it as a basis and cautiously egged them on, telling one that the other said he could do a certain piece of work in three hours. "Well," he remarked, "if he does it in three, I will do it in two and one-half." Not long afterwards, I had a chance to let them go it.

It was a drum with a friction housing; it had to be bored from 4 inches to 5 inches and rims turned for the housings; the piece had been taking five to five and one-half and sometimes six hours. Setting the limit at five and one-fourth, I let one fellow have them all. This did not just please the other man, as he was not making anything on it. One day, when a number were to be done, I let number one get started and then let number two have one. He said something about "number one being slow and not knowing what a lathe was;" at any rate, he started after number one and each did as he said—three, and two and one-half hours on the work. Now it is war to the knife on both machines, and the way work comes from those two lathes is a joy to the machine foreman and superintendent; and what is more, the fit and workmanship are perfect.

One piece number one does that has never been equalled is a cast-iron nut to bore and thread. It is cored to 2¾ inches and has to be bored and threaded for a 3⅞ screw, square thread, two threads to the inch. The bore is 12 inches long; it is a piece of work that is awkward to set up and get true. The time formerly taken to do it was from two and one-half to four hours; the limit was set at two and one-half. This man does nine and one-half in ten hours.*

Other classes of work on these two machines are crank discs for engines from 10 by 14 to 16 by 19, spiders and gear rims, drums and housings, and large shaftings. Some of the times made on the above are as follows: The crank discs have to be faced off on the rims, filleted on one side, shaft hole bored 3⅞ hub, faced, and filleted. The time set was one and three-quarter hours. When the man has six

* Since this was written, he has increased his output to ten and one-half in ten hours.

or seven, he does them in the average time of one hour. They used to take two hours. When one operator has several pieces, the total time from start to finish is taken and he is given premium on that time, unless there are unavoidable delays, such as waiting for crane, broken belt, or wait for special tools. These are not charged against the men.

A drum of which both ends must be turned to fit housings used to take five and six hours; the limit, five and one-half hours, produced three and sometimes four a day.

Spiders which have the ends of the arms turned to fit gear rims, and which are bored to fit and faced on two sides showed the following results:

Bolt circle 42 inches; hub 4⅜ by 7; old time 4½, 4¼, 4 hours; time set, 4; done in 3¼ hours.

Bolt circle 44 inches; hub 5½ by 11¾; old time 5, 5¼, 4 hours; time set, 4½; done in 4 hours.

In this work, as in the case of pinions, the formula: "bolt-circle diameter in inches $\times$ $^1/_{10}$ $=$ time in minutes" gave good results with the limits used in the work.

When I first took hold of the work, the castings were around the machines in piles; now it is hard work to keep the machines supplied. In two instances the night men have been taken off the machines and the day men, with two nights till ten o'clock, keep their work always cleaned up. One man in particular runs a Gisholt machine, getting 24½ cents an hour; he is doing the work of two men now, and averages with his premium and overtime $23 to $25 per week, and his work is never returned on account of bad fits, poor work, or as unfinished. It meets all requirements. This is the class of work he has to do: piston heads, rocker arms, set collars, pipe flanges, cylinder covers, cross heads, all kinds of sheaves up to 20-inch, bronze bushings, and a number of other pieces. If two men worked the machine, each getting 24½ cents and averaging three hours a day premium, it would average $37 a week to the company, but as it is, it runs not over $26 at the most. This is the saving of one machine.

On two Jones & Lamson turret machines, most of the times had been set for bolts of various sizes and some of the studs; shortly afterward the men seemed to make a big improvement on the amount of work turned out. On investigation, I found a change in steel had been made from Mushet to Sanderson. Having a set of tools made of each kind of steel, each was given a fair test; when the operators saw the difference in time of the two steels—nearly 15 per cent. in favor of Sanderson—they made no objection to a decrease in time; both cold-rolled steel and black iron were worked in the test.

Some of the times on these Jones & Lamson machines are indeed remarkable, as they go way beyond the times made by the makers themselves:

	Number per hour. Makers' time.	Time set.	Time made.
Bolt 6 by ⅞, 1½ inches thread, countersunk head....	5	4	10
Bolt 5¼ by ¾, 1 " "	6	5	9
Bolt 6⅝ by 15/16, 1⅞ " "	7	5	9

The above times set by the shop were made with Mushet steel and medium quality lard oil; on the trial of Sanderson steel, the time was raised one bolt per hour. These are only representative times. Some work done in 10 and 12 hours on these machines is as follows:

22 bolts 1 by 5, 24 1 by 4⅜, 20 1 by 4⅛, 16 1 by 4½, 16 1 by 4, done in 9 hours.
70 bolts 3¼ by ⅞ in 6½ hours.
80 bolts 1 by 4 in 10 hours.
80 bolts ⅞ by 3¼ in 8½ hours.

Studs are also done on these machines; the formula we found for this was:

Length of thread $\times$ diameter $\div$ 2 $=$ time in minutes for the stud. This was not as accurate as desired, but served to double what was then being done on studs.

On the pinion lathes I found the reverse to be the case—that the Mushet would stand better in a sandy steel casting than the Sanderson. The times on some of the pinions, both shrouded and plain, is something remarkable. One in particular is a heavy shrouded pinion 5½-inch bore and 6½ inches long; the ends of the teeth are turned off at the shrouding from $^1/_{16}$ to ⅜ of an inch on both sides, and pinion is faced on two sides; the time on these pinions was from four to seven hours. The limit was set at four and one-half hours, so as not to discourage the operator. The time he made on those pinions was five in a day of ten hours. It was only after showing the operator how to set and sharpen his tool that this time was made; the time that is being made regularly now is 3½ to 4 a day. By taking a large number of pinions and times, the following formulas were devised to give the man a fair chance to make two hours a day for himself; this was one of the things aimed at, so the men would feel more content to work harder on outside stock, on which no limit had been set:

For a plain steel bore, diameter of bore $\times$ length of bore, $\div$ 12; for a shrouded steel pinion, the same product $\div$ 10.

In some cases this allowed a little too much, but in the main, it comes quite close, for bores from 2 to 6 inches in diameter and 3 to 10 inches long. Here is a small list of pinion sizes, limits, and new times:

OPERATION.	RECORDED TIME.				BEST TIME.	SIZE.	MAT.	TIME. LIMIT.
Bore and	5	5½-3	3-5	4½	2¾	5½ by 5⅞	Cast steel	4
face 2			4½	2½	1¼	5½ by 6¾	"	2½
ends in-		2½-2	2¼	2	1½	3 15/16 by 7½	"	2
cluding		3	2½	3¼	1	3 15/16 by 7	"	2¾
shroud-		2	2¼	2¼	1¾	2 15/16 by 5¾	"	2
ing,	2	1¼-1½	2½	2	1⅛	2 15/16 by 3 15/16	"	2
			4½	7½		6½ by 5⅞	"	3
			4			3 by 7	"	3
		2½	2¾	3¾		3 by 5	"	3
		2½	5-4			3¾ by 7	"	3
				3.20	1¼	4 by 7	"	2¾
		2.10	3½		1¾	4½ by 7	"	2¾
		2	2¾		1¾	3 15/16 by 4	"	3
	2¾	1.55-1.40		3½	1¾		"	2

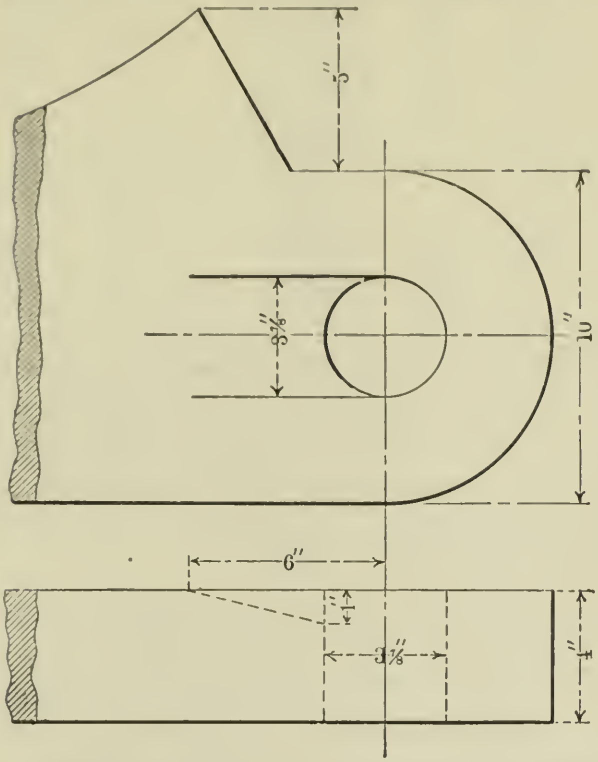
On the shafting lathes, it has been somewhat difficult to obtain fairly accurate times; some of the stock is purchased outside, rough, turned with the centers still on, and the rest is forged in the smith-shop; in both cases the irregularity in the quality of two pieces from the same lot will make from three-quarters of an hour to one and one-half hours difference in the finishing of a piece.

One piece of work in which this shows clearly is the screw for the nut before spoken of; it is of forged steel, 2 feet 8 inches long and 4⅞ inches in diameter, with 2 feet of thread. When purchased outside, it is turned to within $^1/_{32}$ of size; when forged in the smith-shop it is from ⅜ to ½ larger than required size, but I have seen within a short time, a home-forged one and a purchased one follow each other in the lathe; the home-forged took two hours to bring it in shape for the thread, and the outside one two and one-fourth hours. These screws have been divided into four operations:—ends and centers, rough to $^1/_{32}$, finish, and thread. On outside ones, the same but for the roughing, the times are divided thus:—ends and center, ½ hour; rough, 2½; finish, 2½; thread, 2½. When a man has the rough-forged ones, he usually does two a day, while of the outside stocks two and one-half a day is good.

A shipper shaft is about the same; it usually takes four hours to rough one to $^1/_{32}$ and three hours to finish and polish.

For shafting I have no formula or rule, because on different machines it takes different times, and the men feel that if they are not given as much on their machine as someone else is on his, we are trying to cut them. So we try as much as possible to keep one class of work on one machine, but when the variety of sizes in the machinery of two different classes of machines, ranging in capacity from 60 to 100 tons is considered, all being worked at once, the difficulties encountered can readily be seen.

The improvement on the planers has not been very marked; there are only one or two instances that are worthy of note. Planing a slot like this in a steel casting used to take two and one-half to three hours; a limit of two hours made the resulting time one hour. Upon being shown how, the operator did a number in twenty-eight to thirty-two minutes each, but the Sanderson steel would not stand the work; three-quarters of an hour each through the entire day is what is being done, on a 40-inch planer.



STEEL SLOT. PLANING TIME REDUCED FROM THREE HOURS TO FORTY-FIVE MINUTES.

7 by 7 cylinders (double) have taken as long as ten hours to plane, but now on a limit of six hours are being done in four. These pieces have to be set three times—once for the cover and valve seats, and once each for exhaust and live-steam flanges.

On the 90-inch planer, improvement has been made on every piece done; a steel base plate has been reduced from twelve to seven hours, the limit being nine and one-half; in taking a deep cut, very frequently the operator will set his tools tandem, and do the work much sooner by taking in one cut what usually took two.

These last two pieces will do to refer to in respect to drilling; the 7 by 7 cylinders have seventy holes and five stuffing boxes; sixty-eight of the holes have to be tapped; there are four sizes of holes and five settings. The time on these cylinders is four hours, but time and again they have been done completely in two hours, and in some rare cases of soft iron and things just right, have been done in one and three-quarters, which is just one-quarter of what it used to take.

The base plate was a fifteen to eighteen-hour affair. There were some sixty holes $^{15}/_{16}$ diameter, 2 inches through; four holes 2 inches diameter and 8 inches through, and two large holes to be bored out from 2½ to 3 inches through 5 inches. All these holes are cotter-faced on the other side. The working of this piece was made up to fourteen-hours limit; it is strange if it is not done in ten hours now.

These are just sample cases of what has been done in the drilling; it has been so in nearly all cases, although the timing on drilling was set principally from standard tables, and not from actual work.

The changing of a jig or the making of a double jig has made some very great improvements in drilling; links furnish an example. They are ½ inch and ¾ inches thick and have a $^{13}/_{16}$ hole drilled in each end; they are of bar steel. Two hundred a night was considered a night's work, but by two jigs, on a sliding base, on another drill, they are being done at the rate of thirty an hour, on a limit of thirty-five.

I will now take a piece through the shop from stock to finished piece, and show the improvement on it. The example will be a cast-steel base plate weighing nearly 4 tons; it goes first to the planer and has the bottom planed, then to horizontal boring bar to have hub turned, to horizontal drill for four pin holes, which takes four settings; the holes are bored to 3½ by 8 from 3 inches; then it goes to the radial drill for the finishing drilling.

	Planer.	Horizontal Boring.	Horizontal Drill.	Radial Drill.
Old Time, hours	12	14	12	16
Time Limit "	9½	10	9½	14
New Time "	7	7½	7	10

A 10 by 14 engine bed goes through the same process except for babbiting.

	Babbit.	Planer.	Horizontal Boring.	Horizontal Drill.	Radial Drill.
Old Time, hours	5	7	14	3½	4
Time Limit "	4	6	11	3½	3
New Time "	2½	4¼	7	3	2

The result of the improved time in all departments is the decrease of one and one-half to two days' time in the erection of a machine, which is no small item when one machine a week is called for, besides other work going on at the same time.

Of things that I have noticed, just a word. If a man has a finished piece to remove from his machine and does not find a helper handy, rather than run all around and look for one, he will take the piece out himself or ask anyone near to loosen up the chuck and tail stock and then lift it out himself.

The men pay stricter attention to work, as a minute lost is hard to gain.

Their fits, in comparison to some of the men who do not earn premiums, are far better, and they turn out a better class of work.

Each man is very careful to measure up a piece left in his machine by a night man, and the least error is reported, thus making each man an inspector on the other man's work. The fear of each man is that if the other has made a mistake, premium time on that piece would be taken from both when the error was found by the inspector

The improvement in time for the machine department is from fifty hours a week when first started to two hundred and sixty just a short time ago; very shortly for the entire shop seven hundred hours a week will not be uncommon.

The pull on the machines is felt in the power house, and has made the ammeters rise from 200 to 500, which is not a very bad showing.

The premium system gives a more accurate time on work for cost purposes than the time ticket made out by the men; on the time ticket, waits for certain tools and frequently machine repairs are charged up to the order number in the machine at the time, whereas on the premium time they are made separate items. The premium for each day is stamped on the workman's time slip by the premium clerk before the tickets are sent in to the time keeper.

So much for the premium system, for the shop and the man; and so long as the man is treated squarely, so long will the premium system prosper in the shops.

LIQUID FUEL FOR POWER PURPOSES.

By Arthur L. Williston.

Professor Williston's article represents actual experience with the mechanical aspects of the use of liquid fuel probably more than any other contribution to the literature of this important subject which has yet appeared. And the illustrations, like the text, represent actualities, and not theories. They are taken from installations in which the problems have been worked out to a successful conclusion under the conditions of daily work and average conditions. In view of the rapidly increasing use of liquid fuel and the economic changes which will result therefrom, this article has unusual importance. The economic side of the question will be discussed by Professor Williston in a succeeding article.—The Editors.

THE use of crude oil or petroleum as a combustible under steam boilers has long been a fascinating subject for engineers and steam users. The ease with which such fuel can be handled and controlled; the freedom which it gives from dirt and smoke; and the thermal advantages which it possesses over other kinds of fuel, have made it a most desirable substitute for coal wherever and whenever economic and commercial conditions would permit its use. Until within a short time, however, the comparatively limited supply and the difficulty in the way of its cheap transportation from the oil fields have prevented its extensive use, and only in the most favored localities have manufacturers been able to burn it to advantage for power purposes.

In 1887 the Pennsylvania Railroad, in its efforts to improve its practice in the direction of fuel economy and to decrease the burden that the heavy annual payments for coal place in the way of cheap transportation, made a careful series of tests on oil burning. Oil had, even at that time, been extensively used in Russia for locomotive fuel, and the officials of the Pennsylvania Railroad were able to profit by the experience of the Russian engineers, so that they had little difficulty in getting satisfactory results from the oil so far as combustion was concerned. In fact, the official reports of the tests show that the oil burning was an ideal method of firing, easily regulated and always under perfect control. It gave absolute freedom from smoke and cinder, and, at the price of oil which then prevailed, it was thought that there would be, on some parts of the system, a slight economy as well, when all things—especially the handling of coal and ashes and the cleaning and repairing of the locomotives—were taken into account.

But the road on all its branches was then using about 8,000 tons of coal per day, or an equivalent of 52,000 barrels of oil per day. It was estimated that if any considerable portion of this amount of oil were to be used it would so enhance its price, in accordance with the laws of supply and demand, as to make any advantage of the oil burning disappear. The idea was therefore, for the time, abandoned.

Some five or six years later the Chicago, Burlington & Quincy Railroad made a similar series of investigations, but at that time the relative price of oil and steam coal was such that those in charge decided that a change was not desirable. They came to the conclusion, too, that if they were to use oil as locomotive fuel over the whole system, they would need about all the oil that was being produced at that time.

During this period, when the price and the limited supply of oil made it undesirable for locomotive fuel, there were some manufacturing plants that were so situated that they could use oil under their boilers with economy, and because of the advantage from a military point of view, numerous experiments in oil burning were being carried on by several of the naval powers, but its use did not become at all general. Recently, however, the discovery of new oil fields so extensive that there is good reason to believe that the oil wells will not be soon exhausted, and that there is an assured supply to meet the demands of the future; the construction of pipe lines which very materially reduce the cost of transportation; and the high price of coal which has prevailed in many manufacturing districts, have combined to give a new argument for the burning of crude oil for power purposes. And it is probable that during the past two years there has been greater increase in its use than in all the previous time since mineral oil was first discovered. Already some manufacturing plants in the eastern States, which formerly have been dependent on the coal fields of eastern Pennsylvania, have found themselves able to obtain a cheap supply of crude petroleum, or refuse oil, and are burning it under their boilers. A number of vessels, also, in the American merchant marine have been fitted, in the place of the usual coal bunkers, with tanks for the storage of the oil with which to feed the burners that have been placed under their boilers; and many others are anxiously awaiting the results of these experiments, ready to make similar installations if these continue to prove satisfactory, or to make improvements upon them as experience may suggest. Experiments of the United States Navy in this direction, too, have already warranted the Bureau of Steam Engineering in recommending that on at least one-third of the torpedo boats and torpedo-boat destroyers, liquid-fuel installations should be effected without delay; and a Board of Tests of Liquid Fuel for Naval Purposes, authorized by Congress, is at present conducting an elaborate series of tests to determine the best conditions for oil burning on all classes of vessels, including the armored cruisers and battle-ships.

These facts will give some appreciation of the interest which is now being taken in many sections of the eastern States in oil as a source of power; but in the western and southwestern States, where steam coal has always been both scarce and poor in quality, and where the question of transportation from the new fields in Texas and California has been less of an obstacle to the installation of oil-burning equipments than has been the case on the Atlantic coast, the interest is even greater and the use of oil has become far more extensive. In California oil is rapidly driving coal out of the field for power purposes, throughout the State. The same is true in Texas, and of much of the territory lying in between. This general use of oil has affected not only the power and lighting and manufacturing plants in these regions, but also the railroads, and marine transportation as well. With the relative economy, at present prices, between the oil and coal varying from one-eighth to one-half or perhaps less, according to the cost of transportation from the wells to the different points where the oil is consumed, this unusual development is not surprising and the use of liquid fuel for power purposes is still rapidly growing.

One railroad operating in California is now burning oil on more than one hundred and eighty of its locomotives. Another of the great transcontinental systems is already using oil on about five hundred of its locomotives—which is 30 per cent. of the total number operated by the system—and is equipping others as rapidly as possible. In addition to the use on locomotives, it is using oil on its steamers in San Francisco Bay, and on its river steamers, with very good results.

These few facts are, I believe, sufficient—if, indeed, anything were really needed—to show the very rapidly growing importance of liquid fuel as a competitor for coal; and to remind every mechanical engineer and steam generator of the significance and value of whatever may help in determining the conditions or appliances with which the best results from oil can be obtained, or the relative economy that may be expected from coal and oil burning in any given market.

This whole question is so large, and it involves so many elements—chemical, mechanical, and economic—that there are many problems still to be worked out, and there are many lines on which further investigation is necessary. The experience has thus far been short and more facts are needed. Nevertheless, considerable data have been collected regarding the practice, and some points have already been settled with a considerable degree of definiteness. It is to discuss some of these things that is the purpose of this paper.

In the early attempts to use oil as a power fuel it was introduced into the furnace in bulk without air or steam and without any attempt to atomize it. It was simply allowed to vaporize from iron plates or from the incandescent surfaces of brick or stone within the furnace. With this method of introducing the oil, forcing the fires was manifestly impossible, for the vapor thus given off could be burned only as fast as it was formed and the vaporization was limited by the extent of the surface exposed.

It seems to have been pretty definitely settled now that better results can be obtained by introducing the oil in the form of a finely divided spray by means of an atomizer; and, so far as the mechanical part of the problem is concerned, it may be said that the greatest difficulty was overcome when it was first realized that the success of oil burning depended largely upon the efficiency obtained in atomizing the fuel. With the oil sprayed under the boilers in this way, it has been found that the fires can be forced at will—even to a degree beyond that which is possible with coal under forced draft. The rate of vaporization and the combustion of the oil are limited only by the size of the burners and by the velocity with which the air and products of combustion can be forced through the furnace.

Burners.—Both compressed air and steam have been successfully used as the atomizing agent, and the majority of the burners now on the market are designed with the openings adjustable so that they may be used with either. Most of these are patented devices, and a very large number of them have been brought out. The activity of the inventors in this direction can be judged from the statement made in the preliminary report of the Liquid Fuel Board, that new patents for liquid-fuel appliances were being issued in the United States at the rate of thirty a week. Nevertheless, there is great similarity in principle and in action between these different burners, and therefore for our present purpose it will be necessary to describe only two or three typical ones.

Figure 1 shows a section of the Reed burner, which has been extensively used with good results. The oil is admitted through the small three-eighths inch pipe in the center, and the steam used to atomize it enters through the annular chamber marked A. The size of the opening through which the steam flows may be varied by turning the sleeve B either to the right or to the left, and thus moving the casting C backward or forward. The stuffing-box D is needed to prevent the steam from leaking at the back end of the burner. A limited quantity of air is admitted through the center of the burner, as indicated at E. This air has good opportunity to become thoroughly mixed with the steam and the atomized oil as it is forced into the furnace, and thus helps the combustion. It is not, however, essential to the action of the burner, and it is probable that the oil would be just as perfectly atomized if it were not present. In fact, many burners now on the market are designed without this provision, and consist only of the inner tube for the oil and the surrounding annular passage for the steam or compressed air, whichever may be used as the atomizing medium.

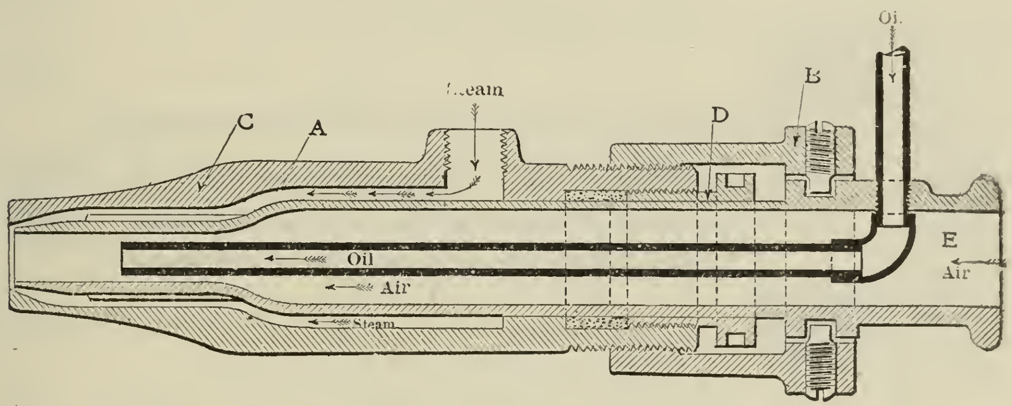


FIG. I. SECTIONAL VIEW OF REED BURNER.

The chief virtue of this burner is its simplicity and the fact that it thoroughly atomizes the oil. Many other burners have additional features tending to give the spray a rotary or whirling motion as it is forced into the furnace, or to mix it more thoroughly with the entering air by variously shaped tips. But experience has shown, so far as I am aware, that such features only complicate and make the burner the more easily clogged by dirt or deposited carbon, and that they do not really add to its effectiveness in atomizing the oil into a finely divided spray. This seems to be the only criterion by which the efficiency of a burner should be judged.

Figure 2 shows the top view, end view, and section of another type of patented burner which is used extensively on one of the railroad systems of the western United States. It differs from the one just described only in being rectangular in section, thus making possible the use of larger openings through which the steam may be forced at

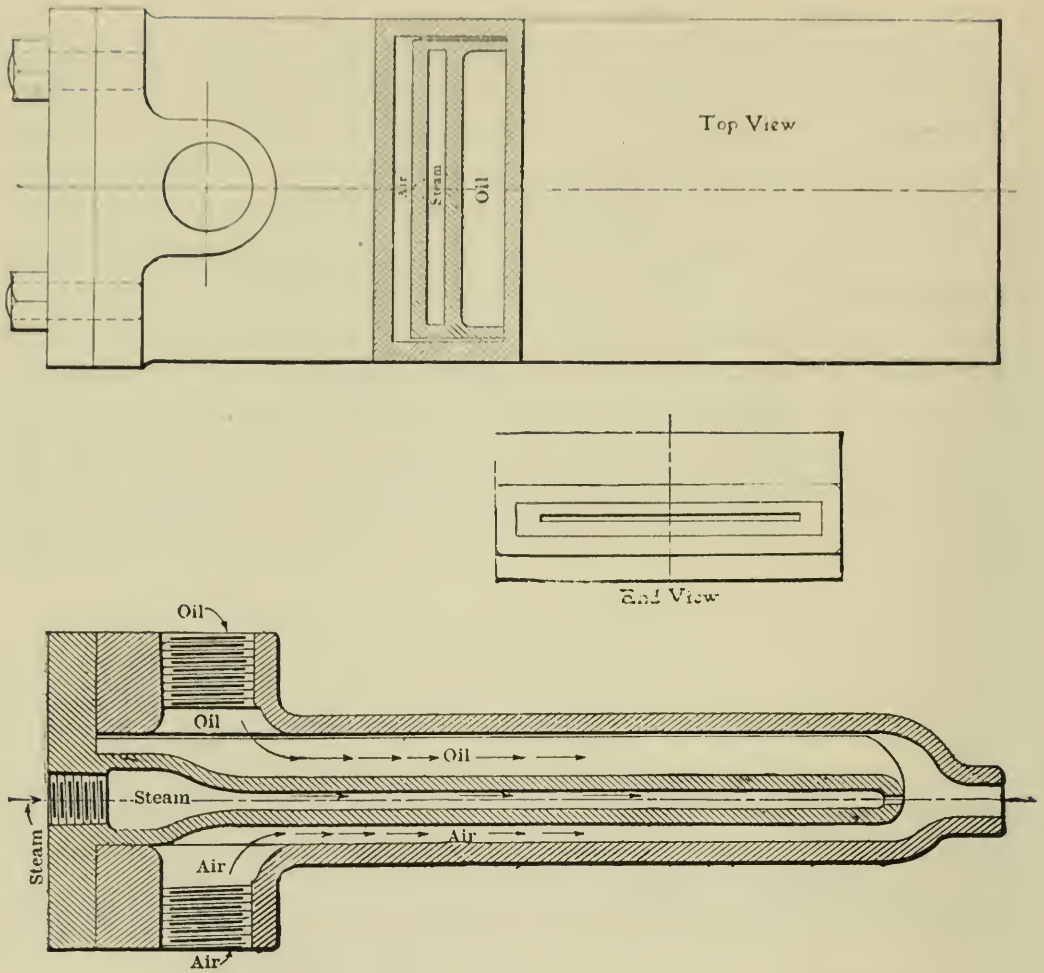


FIG. 2. TOP, SIDE, AND END VIEWS OF BURNER FOR LIQUID FUEL.

high velocity, than could be had in a burner of circular cross section like the Reed burner. In a circular burner, if the diameter of the openings were increased beyond a certain point, the steam or compressed air could not come into intimate contact with all parts of the oil jet as it entered, and the efficiency of the atomizing effect would be lost. But in the burner shown in Figure 2 it will be noticed that the oil as it enters flows in a thin sheet over the steam passage, and as it falls comes directly in contact with the wide jet of steam as it emerges from the rectangular opening. There is another good feature in the design of this burner which should be noticed. The oil as it enters passes over the top of the casting forming the steam chamber, becoming more fluid as it is heated, and therefore more easily atomized.

Air *versus* Steam as an Atomizing Medium.—A difference of opinion exists as to the best medium for atomizing oil. Both air and steam have been used with excellent results, as has been already stated. But it is difficult to say positively which is the more economical.

In large plants—or in small ones where a supply of air at pressures of from 2 to 5 or 10 pounds per square inch is available—air is unquestionably more economical than steam, so far as the spraying of the oil is concerned. Where it is necessary to use air at higher pressures, the difference in economy is not so clear, as the cost of each cubic foot of compressed air increases rapidly as the pressure increases, but its ability to atomize oil does not increase at anything like the same rate. The most economical results obtained from the recent tests of the United States Navy are with air at between 1 and 2 pounds pressure per square inch with the Oil City Works air burner; but not all burners would work with air at this low pressure. Weighing the steam that was used to furnish the compressed air, it was found in these tests that less than 2 per cent. of all the steam generated in the boilers was necessary for atomizing the oil with the air pressure between 1 and 2 pounds, while 4 per cent. of the steam generated was found to be needed when the air used for atomizing was at a pressure of 4 or 5 pounds per square inch.

There is, too, another advantage of using large quantities of air at low pressures, arising from the fact that all the air thus introduced into the furnace helps in the combustion of the fuel and reduces the chances of small amounts of vaporized oil passing up the stack unconsumed. Steam, on the other hand, when it is used for atomizing, tends to dilute the air which is needed for combustion as it enters the furnace. This, of course, is undesirable. The smaller quantity of steam used, therefore, the better from this point of view, as well as from the standpoint of steam economy.

With a burner having its steam and oil orifices properly proportioned, it is therefore probable that the highest efficiency can be obtained with the steam at full boiler pressure, although further experiment is still needed to establish this point definitely. The experiments available show that from 5 per cent. to 6 per cent. of the total steam generated may be necessary for the burners when steam is used instead of air.

In this connection it may be well to add a few words regarding the action that this steam has in the furnace, for this is a matter that is very generally misunderstood. It is often supposed that because the steam takes part in the combustion chemically, it adds something to the heat generated, but this is not the case. Its effect is only to dilute the products of combustion in the same way that the nitrogen of the atmosphere does, and in a similar manner, too, it carries a certain amount of heat with it up the stack. It is true that the steam is wholly or partially decomposed on reaching the hottest part of the furnace and, if there is not sufficient air at that point, it gives up part of its oxygen to the carbon in the oil, leaving free hydrogen. It follows the same reaction here that occurs in the production of water gas. If a sufficient supply of air is admitted later, however, this hydrogen is all burned before it leaves the furnace, but the amount of heat developed thereby just balances the heat that was absorbed by the decomposition of the steam, so that there is neither a gain nor a loss of heat produced by this chemical action, unless some of the hydrogen escapes up the stack unconsumed.

Its only effect on the fire has been to subtract heat from the furnace near the burners, thus decreasing the intensity of the fire at that point, and later to add just the same amount of heat to the combustion farther away from the point where the oil enters. Practically, then, the effect of this steam is simply to add to the length of the flame and to carry it farther back into the furnace than it would otherwise go. This is often of very great value, as it prevents the intense local heat at one point which is likely to cause most injurious local expansion strains in the boilers, and it tends to give to all parts of the heating surface more nearly the same efficiency that the heating surface within the fire box usually has. So far as the total heat available for evaporation is concerned, however, its effect is, as has already been stated, almost exactly the same as an equal amount of nitrogen in the entering air.

Pre-Heating the Oil.—Fuel oil may be successfully sprayed into a furnace at the temperature of the boiler room, but this can be much more readily accomplished if the oil has been previously heated before coming in contact with the compressed air or steam. In the description of the burner shown in Figure 2, which was designed for locomotive use, attention was called to the way in which the pre-heating was done in that instance. This method is satisfactory for railroad use, but for stationary boilers it is usual to adopt a somewhat different method which can be more fully controlled.

Figure 3 shows such an oil heater in front of the boiler setting. This heater consists of a short piece of 6-inch or 8-inch steam pipe, capped at both ends, through which a long coil of small steam pipe is passed. The oil enters at the bottom, flows up around the hot steam coil, passes out at the top, and on to the burners.

The temperature to which the oil should be heated will vary with the character of the oil, a heavy, sluggish oil requiring a higher temperature than a light, volatile oil. For most oil used for fuel purposes, however, the range will be from 180 degrees F. to 220 or 240 degrees F. In no case should the oil be heated hot enough for any considerable portion of it to be vaporized before it reaches the burner, as this would interfere with the atomizing process; but so long as this condition is not reached, the higher the temperature to which the oil is heated the better, as the warmer it is the more fluid it becomes and the more rapidly it is vaporized after leaving the burner.

The Furnace.—The proper design and construction of the furnace is of the very greatest importance in its effect on the efficiency of the oil-burning plant; and, just as the burner was found to be the key to the control and regulation of the fire, so the furnace more than all else determines the efficiency of the fuel combustion. The furnace design, therefore, will be controlled by the requirements for perfect combustion. And these requirements for perfect combustion are very simple. They are: *That every particle of fuel shall come in contact with no more and no less air than it theoretically needs for its complete combustion;* and *that it shall come in contact with this air before it reaches a part of the furnace which is below the temperature of ignition.* Therefore, there are three ways in which the furnace may fail of perfect efficiency.

1. It may supply to some of the fuel more air than is needed, wasting heat by increasing the temperature of air which does not take part in the combustion.
2. It may supply to some of the fuel less air than is needed, thus allowing some fuel to pass up the stack unconsumed.
3. The temperature in parts of the furnace where the air and the fuel come together may be below the temperature of ignition, which means that that fuel will be unconsumed.

In designing a furnace all of these conditions must be carefully considered and, if possible, fully met. The realization of them is far less difficult with liquid fuel than it is with any form of coal, and the experience of the last few years has clearly demonstrated that perfect combustion can be very nearly reached with almost any burner, provided proper care is taken in the furnace design; and without this, I am convinced that it is impossible for any burner to burn oil efficiently in large quantity. In a small flame it might be possible for the oil vapor to be so uniformly mixed with exactly the right quantity of air as to form a *true explosive mixture* that would give instant and perfect combustion throughout its mass. This condition may be very nearly met in the small flame of a hand blowpipe, but with the large burners that are necessary where oil is used as fuel under the

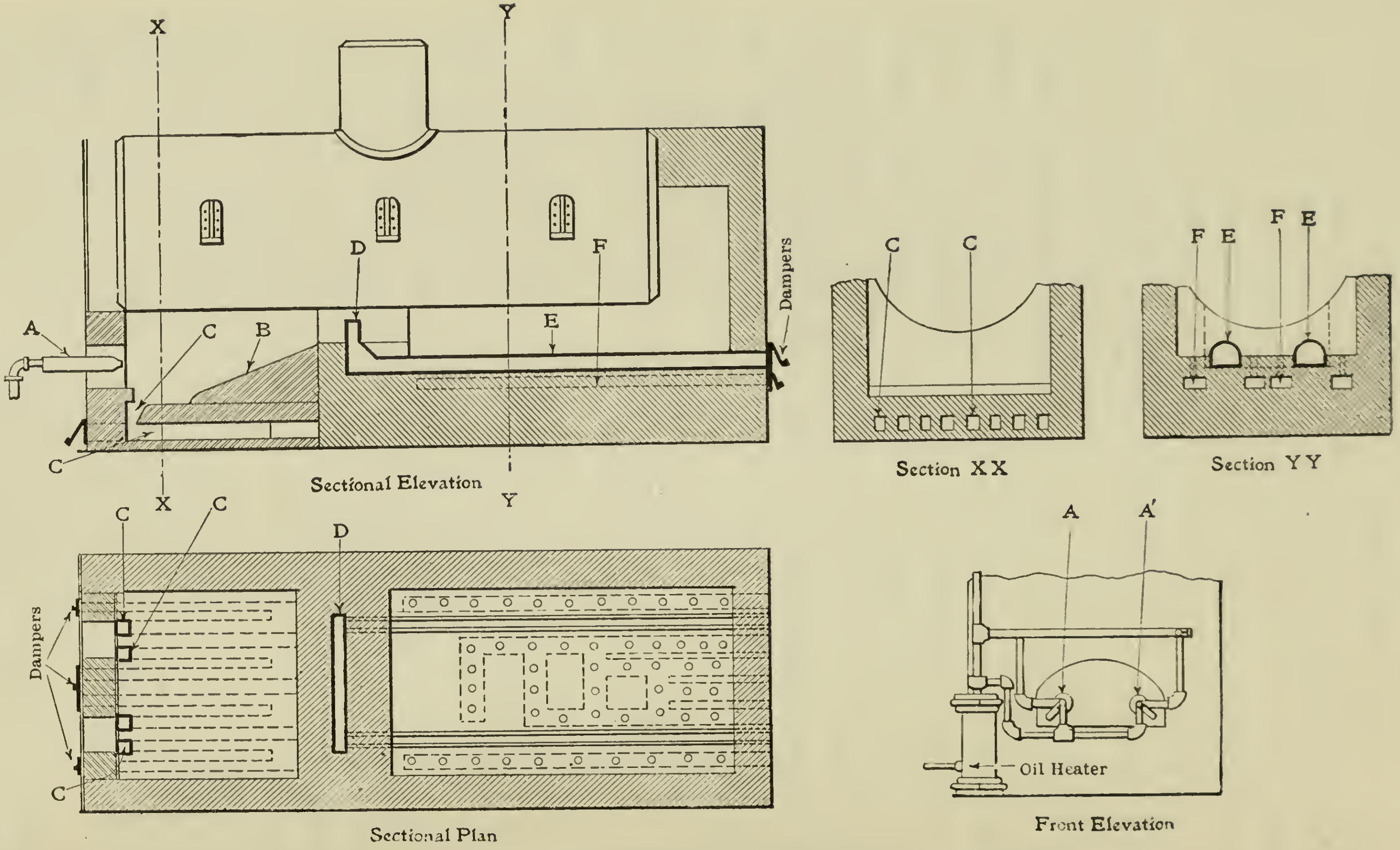


FIG. 3. OIL-BURNING FURNACE FOR MULTITUBULAR BOILER.

Scale ⅛ inch equals 1 foot, approximately.

boilers this is not possible, and no burner has ever been constructed that will accomplish that result.

In the practical problem of burning oil on a large scale, *time* is required for all the oil to be completely vaporized and for this vapor *all* to come in contact with the air which is needed for its combustion. It is therefore necessary to have a very considerable volume to the flame and a combustion chamber where it can be confined until the chemical action is complete.

No burner yet devised can spray oil at all times with perfect uniformity, or evenly mix it with the air as it enters the furnace, so it is necessary either to admit more air than is really needed with the oil, or else to admit small additional quantities at different points in the furnace for the combustion of any fuel that might otherwise escape unconsumed. This latter method has been found to give by far the most satisfactory results, and with it the fires can be regulated with great nicety. This additional air should be admitted at points in the furnace where the temperature will be sure to be above the point of ignition, and also where there is a good circulation in the products of combustion, so that it will be sure to meet any unconsumed oil vapor. In this way the fuel may be completely consumed with practically no excess of air. When oil is used as a fuel, therefore, it is necessary to design a furnace of sufficient size to allow time for the complete combustion of the atomized oil before it leaves it. The furnace should also have provision for admitting the air needed for perfect combustion at different points, and it should be so designed as to maintain in every part a very high temperature.

Figure 3 shows the construction of one of the furnaces for a battery of multitubular boilers 6 feet in diameter and 18 feet long. The oil is admitted through two burners, A and A^1; which are placed in holes drilled through the fire door. These burners are set so as to direct the flame against the fire-brick incline, B. A limited amount of air is admitted with the steam and oil through the burners, but additional air is supplied to each burner through the four openings marked C. As the flame passes over the bridge wall, more air is admitted through the long, narrow opening marked D. All along the bottom of the chamber between the bridge wall and the rear of the furnace setting there are a large number of very small openings through which additional air may be admitted to the flame as it is needed for perfect combustion. All of these different sets of air openings are furnished with dampers which may be nicely adjusted so as to admit just the quantity of air that is needed in each part of the furnace.

Mica peep holes are provided at different points in the setting, through which the fireman can watch the flame in every part of the furnace, and with very little practice he is able to adjust the air supply as he varies the quantity of oil burned, so as to get perfect combustion with almost no excess of air. Under these conditions it has been found with this furnace that the whole setting will warm up to a uniform temperature and that the entire furnace, including the mixing chamber at the rear and its walls, will become perfectly transparent and very bright red in color. A slight change in the air supply above or below the proper amount, however, will disturb this transparency, so that the fireman has had no difficulty in nicely regulating the combustion. With the dampers rightly adjusted, the products of combustion are entirely free from color and odor and, running the plant from September to June, the flues are found each June as clean as they were when the boilers were started up in September. After this setting is uniformly heated, it will maintain its temperature for a long time, and at night it has been found that the oil could be turned off thirty minutes before the engines were shut down at the time the plant was carrying its heaviest load, and yet the heat given off by the boiler settings was sufficient to do the required work with no perceptible falling off in boiler pressure, and that during the night, with no fire whatsoever, the pressure would drop only about fifteen or twenty pounds before morning.

Referring again to Figure 3, it will be noticed that all the air that enters the furnace has to pass through long, narrow passages of hot fire-brick or tile. This, of course, helps to maintain the uniformly high temperature necessary for perfect combustion. The passages that lead to the four openings, C, are made by leaving spaces between the fire brick which are laid in the space that would ordinarily be used for the ash pit. This brick, after the fire has been started, becomes very hot and, as the openings are small and the passage of air correspondingly slow, the air has a chance to be well heated before it reaches the flame at the burners. The two passages that lead to the opening in the bridge wall, D, are made of D-shaped tile (marked E in Figure 3) which project upward into the furnace so as to expose as much surface as possible to the flame. The large number of openings in the space between the bridge wall and the rear of the setting are made by making a small V-shaped nick in each brick, thus connecting the furnace with the passages below, marked F, which lead to the rear of the setting where the controlling dampers are placed.

The flame as it enters the furnace is directed against the incline in front of the bridge wall in such a way as to cause strong eddies and currents which bring every part of the flame close to these air openings at the bottom of the furnace; and, as the setting is continuously incandescent, ignition of any unconsumed oil vapor is sure to take place even with a minimum air supply.

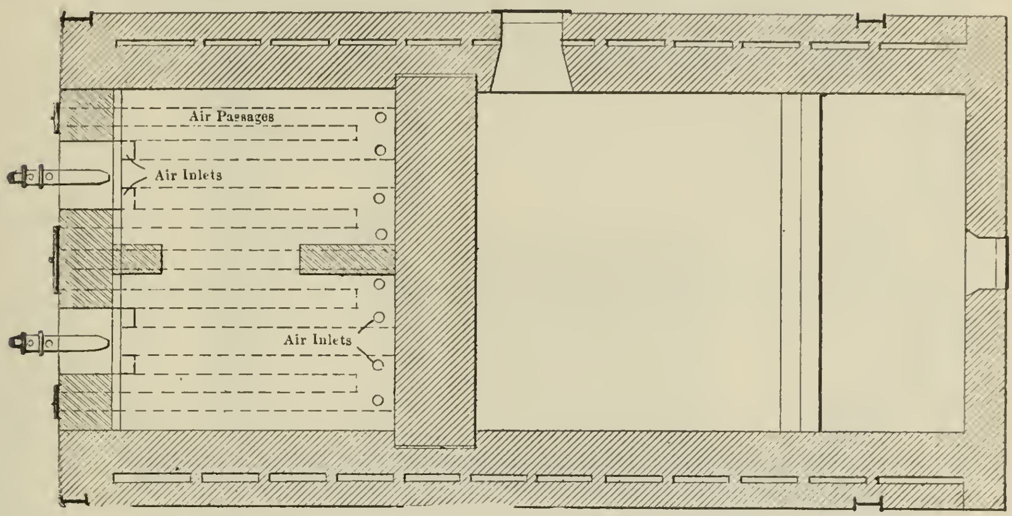
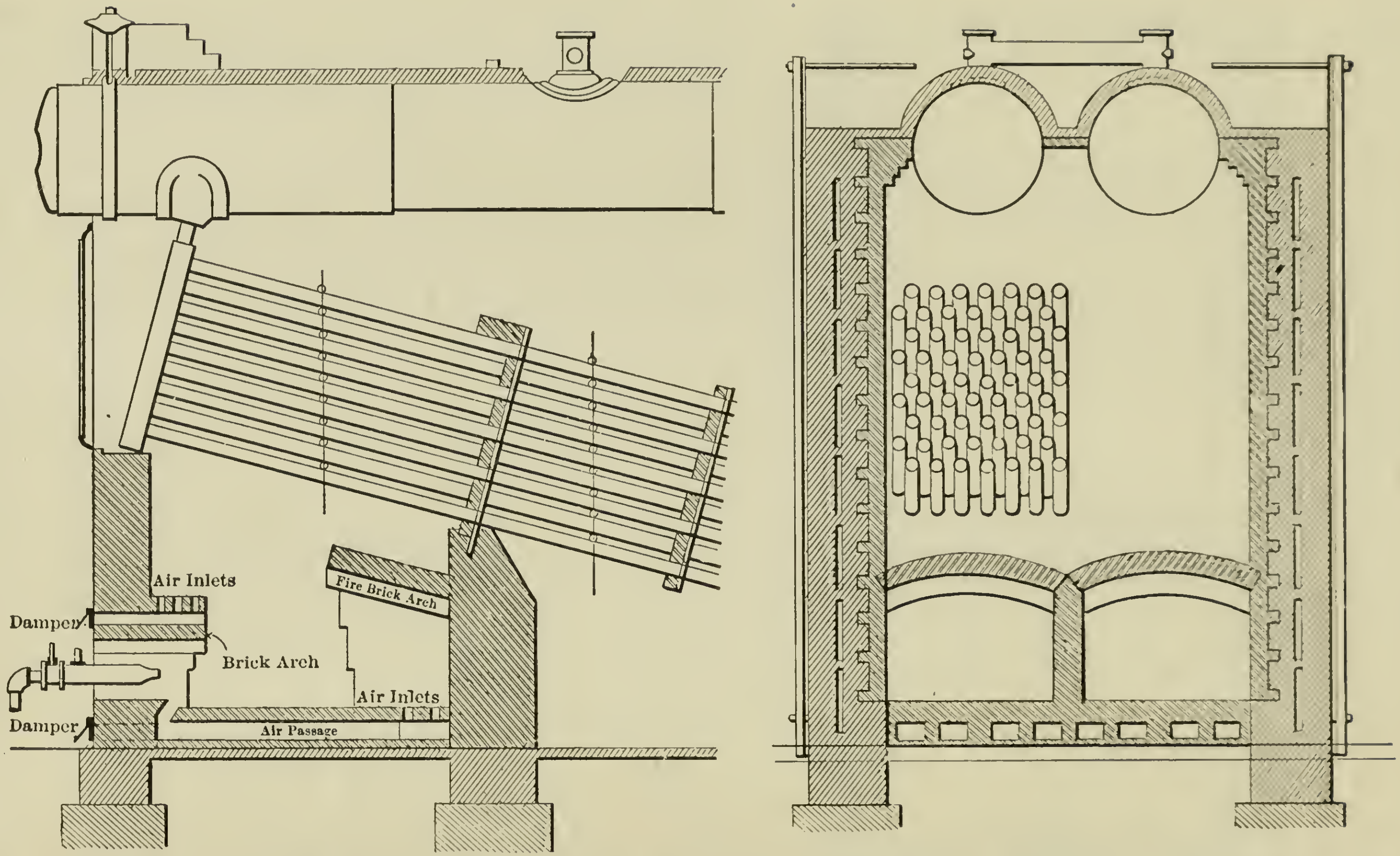


FIG. 4. PLAN OF OIL-FIRED BABCOCK & WILCOX BOILER SETTING.

Figures, 4, 5, and 6 show the plan, longitudinal section, and the cross section of a furnace designed for a 250-horse-power Babcock & Wilcox boiler so as to accomplish these same results with the water-tube boiler. Here there is not the same opportunity that was had in the previous case to have a long combustion chamber virtually running the whole length of the boiler, so that extra precautions have to be taken to insure perfect combustion before the flame reaches the tubes. This is accomplished by means of a fire-brick arch which causes the flame to return on itself before it has a chance to be chilled by the water surface of the boiler. In this furnace, too, there are air passages which admit pre-heated air to the flame at various points. This air enters through the regulating dampers near the floor and passes under the hot fire-brick which forms the floor of the furnace back to the bridge wall, and returns again to the two air inlets underneath each burner. There are also small air inlets near the bridge wall and underneath the main fire-brick arch, through which small amounts of air may be admitted, and there are also still other inlets, for air which is admitted through the small, hollow fire-brick arch at the front of the furnace.

In this furnace the same results are reached as in the design for the furnace of the multitubular boiler which was previously described. Air, in addition to the amount admitted through the burners with the



FIGS. 5 AND 6. PART LONGITUDINAL SECTION AND CROSS SECTION OF BABCOCK & WILCOX BOILER ARRANGED FOR FIRING WITH LIQUID FUEL.

Scale 3-16 inch equals 1 foot, approximately.

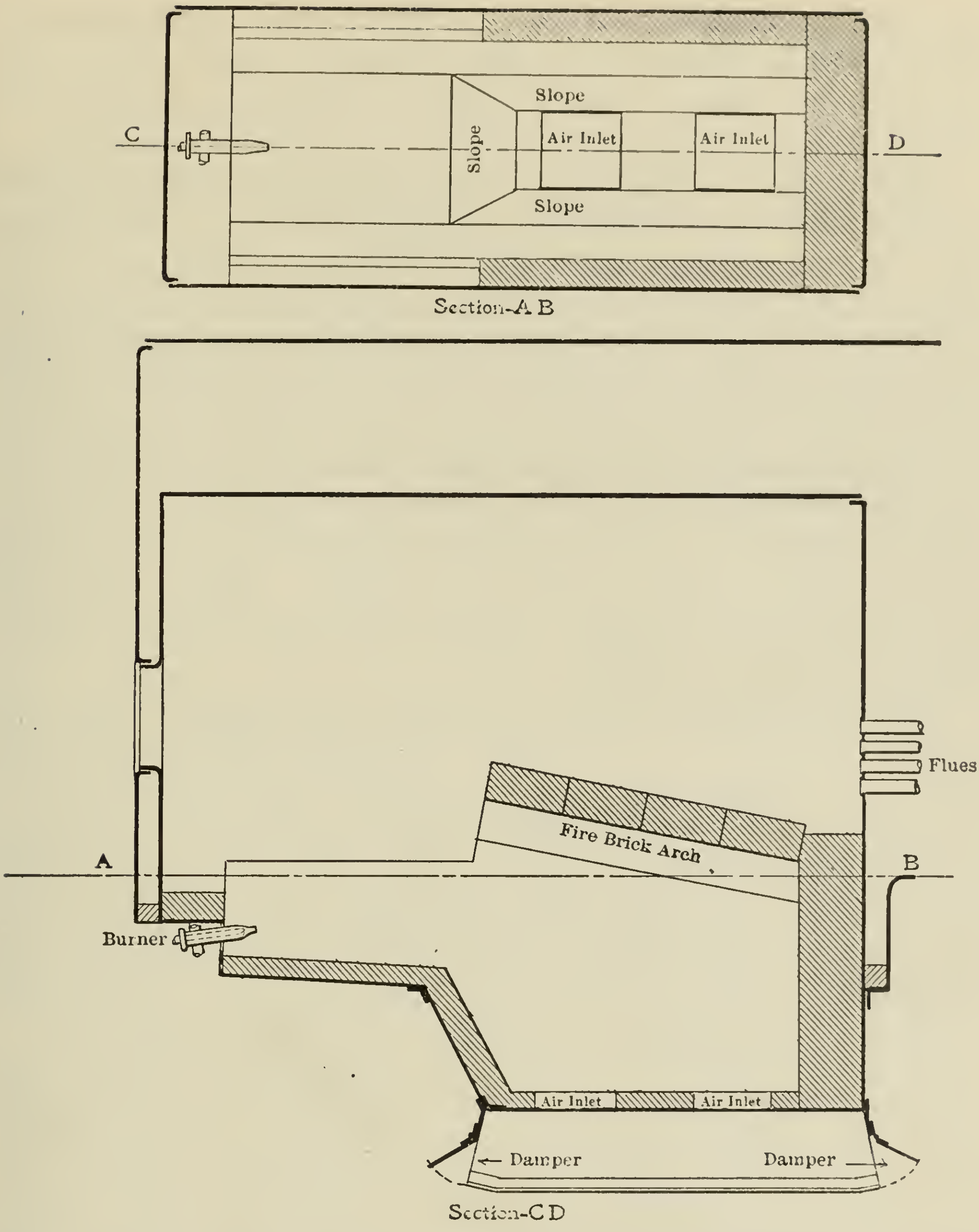


FIG. 7. SECTIONAL PLAN AND ELEVATION OF FIRE-BOX OF OIL-BURNING LOCOMOTIVE.

Scale ⅜ inch equals 1 foot, approximately.

oil, is admitted just in front of the burners, again at the bridge wall, and again just before the flame reaches the tubes, and in each case it is admitted at a point where there is an excellent circulation in the products of combustion. A very large surface of incandescent fire-brick is also present to insure ignition of every particle of combustible. This furnace is 7 feet deep and, as the drawings are made to scale, the other dimensions can readily be inferred from the proportions.

The advantages of heating the air which is needed for combustion are almost too obvious to call for comment. Heat which otherwise would be lost by radiation is in this way saved, and the flame is not exposed to the chilling influence which is exercised by a draft of air entering upon it. Wherever it is possible it is therefore desirable.

Figure 7 shows a sectional plan and sectional elevation of a typical locomotive fire-box as fitted for oil burning by one of the railroads which consume oil most extensively. The idea and purpose of the fire-brick lining and fire-brick arch inside the fire-box is precisely the same as in the furnace for the Babcock & Wilcox boiler just described. There is not here the same opportunity to heat the air before it enters the furnace that there is with the stationary boilers, but it will be noticed that the air is admitted not only at the burner but at the bottom of the fire-box under the fire-brick arch in such a way that it can be accurately regulated by dampers, and also that there is a large surface of incandescent fire-brick exposed to the flame. The fire-brick arch also serves to protect the tube sheet from the intense heat to which it would otherwise be subjected.

The fire-box shown in Figure 7 is about 8 feet deep measured to the tube sheet, but on some of the locomotives having still deeper fire-boxes there is a fire-brick wall—with the fire-brick arch in front of it—placed about 6 feet from the burners, leaving a space for a combustion chamber between this wall and the tube sheet. On some of the locomotives, too, there is a small arch placed over the burners, like the one shown in the furnace for the Babcock & Wilcox boilers, to confine the flame further and to protect the fire-door. Otherwise the arrangement of the fire-box is similar to that shown in Figure 7.

The great variation in the price of oil in different parts of the country makes it difficult to say when a saving can be effected by the use of oil as a substitute for coal. This is a problem which will have to be worked out separately for each locality, and the solution will depend not only on the supply at the nearest wells, but also on the distance from the oil fields and the facilities for transportation at hand. The engineer who is contemplating an oil installation, therefore, will have to consider these things just as carefully as he considers mechanical advantages and savings in labor and repairs, when he is comparing the relative economy of oil and coal for power purposes.

LABOR'S COMPLAINT AGAINST CAPITAL.

By Frederic Hay.

It is quite safe to say that the labor question can never be settled from one side alone—and with all deference to the discernment and the sincerity of those who are seeking as representatives of the employer to put themselves in the employee's place, there is nothing quite so profitable for enlightenment as to hear from the employee himself. Mr. Hay's contribution comes so late that it can not be placed in the logical position near to Mr. Cokely's. It must be allowed to sum up the number which the other article opens. But here it may be most effective in urging again—as Mr. Cokely does so earnestly throughout his paper—as Mr. Kimball does in his conclusion—that labor will never be satisfied and *should* never be satisfied until it is met with larger justice and larger opportunity to increase its earnings than has generally existed heretofore.—The Editors.

THE frequent manifestations of discontent and unrest in the ranks of the many branches of labor, voiced through the medium of their organizations, should it appears to me indicate to the intelligent mind that there must be deep-seated causes for the trouble that will not down.

In the article by Mr. Carpenter in the April number of The Engineering Magazine, on "The Working of a Labor Department in Factory Management," the subject is dwelt on at great length, and the cardinal point is made, perhaps more forcibly than logically, "that the time to stop trouble is before it begins." That I think may be accepted as an axiom. But the question arises *how to prevent it?*

From the standpoint of the employee (to which class I belong) I feel that while, theoretically, Mr. Carpenter's propositions may seem all that is required to "stop the trouble before it begins," yet they do not practically represent the actual conditions that would be satisfactory to the wage-earner. Workmen are averse to the referring of questions to departments, with the delays consequent upon investigation; nor does Mr. Carpenter indicate the *materiel* of which the Labor Department should be composed, which would be a matter of consequence in the event of his suggestion meeting with approval.

Workingmen, as a rule, are not broad-minded or far-seeing; their minds do not in general range beyond their particular trade, and their party politics. They are suspicious of their employer, believing that any new method introduced is to beat them in some way to the employer's advantage. Labor-saving devices generally do not meet their approval; the time-clock especially is looked on with contempt as an invention designed to make further profit out of them; and many men think it creditable to use the means in their power to get even with it—and they do, too.

The existence of labor unions in the present day is in itself great evidence of the unwillingness of employers to concede to their workmen what they believe to be a fair share of the earnings acquired by their industry and skill. The unions were not at their inception designed as a menace to the employers but, as descendents of the Guilds of the Middle Ages, associations of trained and competent workmen for the conservation of their rights, and to secure a uniform wage in their various trades—so that to be a member of a labor union is to imply a competent workman.

Labor is more necessary to capital than the latter to the former (though this may not generally be conceded)—without labor capital could not be employed to advantage. Men need not become mechanics.

No special system can be devised to meet all cases, because all men are not alike—there are the zealous and the careless; the industrious and the idle, *i. e.,* the worker and the fakir. The most successful system in the long run will be that which appeals to the men's honor—and to that alone. The men should by a careful and quiet process of weeding be brought, as nearly as possible, to an equal standard.

One reason for the indifference of the workman to the interests of his employer is the drifting apart that has for years been going on. In former times (not so many years ago) the employer was interested in his men. He had been one of the craft himself. His face was seen in the workshop or factory. He knew the men by their first names. He knew something of their condition and their needs. The men could address him personally if they would.

All that is changed now. These are days of large combinations of capital. The capitalist does not require a practical knowledge of the business. He is not in sympathy with the "hands," with whom he holds no communication, should he ever see them, and so the superintendent takes the place which the employer formerly held.

As the object of business is to obtain the largest return on the capital invested, the duty of the superintendent is primarily to produce that return to his employer by restricting the working expenses to the lowest point. On all questions that may arise he is practically the court of appeal. The employer does not desire to be troubled with the affairs of the "shop."

The foreman comes between the workmen and the "super," as he is known in the shop, and controls the working department. He should be a first-class workman, knowing to a hair what it is possible for the men to do—a man of firm but equable temper, just to employer and men alike, easy of approach—and should strive to preserve order and content. The average foreman does not in my experience represent these conditions. He requires an homage paid to him akin to that of a sovereign; he resents appeals from his decisions, just or unjust; and if a man dispease him, no matter how good a workman, he may expect discharge.

One open cause of discontent on the part of labor is the undisguised hostility on the part of capital. The employer objects to deal with labor's only representative—the union. But objectionable as many features of the union are (and the ranks of labor are aware of them), it is their only protection; through its means have been obtained advances of wages and reduction of hours of labor; it is their bundle of sticks, and for their mutual interests forbearance should be shown by each. After a bitter contention sometimes a slight advance in wages may smooth over the surface for a while; but the discontent remains. That for which labor is contending and without which it will not rest and be satisfied is:

Recognition by capital as a factor in the production of profit. The workman sees his employer grow rich, while his income does not advance; his dollar has not the purchasing power of a few years ago, for the things he needs, and if he have family, his mind is exercised how to maintain them properly. He asks himself questions: Why should he toil so many hours a day and be expected to do so much; why when the business is prospering he enjoys no benefit, though if it be dull he may be expected to take three-quarter time; why, when there are legal holidays he should be "docked" his pay and the foreman be paid; and lastly, for the three months' Saturday half-holidays he should lose half a day each week, when he knows that by pressure he has been made to earn his full week's pay? The holidays, instead of being cause for rejoicing, are the reverse.

If the workmen were treated more as helpers to their employers' prosperity and made to feel that their efforts would be recognized—that when the accounts for the year's business are made up a bonus or percentage of profit would be awarded them, discontent would give place to satisfaction and honest pride in their work.

The views expressed in this paper may not be acquiesced in, but they are not theories; they are the results of experience, and in my opinion it is for their mutual welfare that capital and labor should approach each other with recognition of their mutual interest.

EDITORIAL COMMENT

THE present greatly disturbed condition of the relations of employers and workmen is more than sufficient justification for the space given to labor questions in this number. We are glad to be able to present the subject from so many points of view as can be obtained either from the direct arguments or the *ob ter dicta* of Messrs. Cokely, Hay, Colwell, Kimball, and Buchanan. It is not strange that there should appear, in these several presentations, wide differences of opinion. Mr. Hay advances some views for which employers will have scant tolerance. Mr. Colwell describes certain features of practice which labor leaders will bitterly attack. The essential thing, however, before any adjustment can be hoped for, is that each party shall see that there is another side and shall understand what that side is. Beyond that, the way to solution lies by infinite patience and long striving after common sense on the part of the wisest of leaders both of capital and of labor—by the long exercise of that "voluntary human restraint" which Mr. Cokely upholds in his opening article as the source of all that is best in the world.

* * *

AN example of the false attitude too often assumed by organized labor toward methods for remunerating men in proportion to their productive capacity, is shown in a recent strike at a Rochester shop where the premium plan has been in successful operation for more than two years. Its abolition is demanded, as plainly stated by the labor representatives, because the incentive offered by the system causes the men to increase their output as well as their pay, and this condition is "*not favorable to organized labor*."

The machinists who are working under the premium plan at the Davis shops are stated to be themselves well satisfied; the opposition comes from the union outside, under the advocacy of other members working in shops where the premium system is not in use. This is the sort of interference which Mr. Cokely well says is intolerable.

The aim of the union is distinctly restriction of output to that of the capacity of the slowest workers, based on an acceptance of the theory of the "lump of labor" and of the idea that any increase in the productive power of one man decreases the opportunities of his comrades. That whole theory has been proved in the long run absolutely false. It is hard to see how anyone can cling to it after even the most casual glance at the history of industry. It is true that certain transitional periods have borne heavily on the superseded orders of workers. The shock of change fell most heavily on those least able to bear it. In lesser things, the daily wage worker, though his resources in emergency are least, is still subject to unforeseen changes of circumstance shocking in their suddenness and violence. With the minimum reserve against failure of income, he has the minimum assurance of its continuance. It should certainly be the earnest and conscientious care of employers to avert the disasters of this condition from their employees.

But no such results attend the gradual increases of production secured by modern methods. They are indeed necessary, and at the utmost are behind the constant increase of consumption. And the vital force of most of them is the stimulus of competition. When combinations to restrict competition are effected by capital, they are denounced by labor and checked by the courts as being "in restraint of trade." But when they are forced upon ambitious workmen against their will by the representatives of organized labor—what then?

* * *

THE brief paper of Mr. Frederic Hay, which will be found elsewhere in this issue, contains some interesting side lights upon labor matters which will bear further examination. Thus, Mr. Hay says: "If the workmen were treated more as helpers to their employer's prosperity and made to feel that their efforts would be recognized —that when the accounts for the year's business are made up a bonus or percentage of profit would be awarded them, discontent would give place to satisfaction and honest pride in their work."

It is, according to Mr. Hay, for this and similar purposes that the workmen persist in their efforts for the recognition of their unions and organizations. Now what do we observe in actual existence? Is it the workmen who are demanding premium systems, profit-sharing plans, or bonus systems? On the contrary, all such schemes have been devised by the employers for the purpose of interesting the men in their work and in the attainment of a maximum output, and all of them have been bitterly opposed by the men as tending to differentiate between the abler and the poorer workmen. The workmen—or the unions, as representing the workmen—must be intelligent and fair enough to recognize that any scheme of profit-sharing must, in simple justice and in plain common-sense, apportion the profits distributed in accordance with the degree to which each employee contributed in enabling profits to be made. The careless, time-serving workman is never a profit-maker. The aim of the premium and bonus systems is to select automatically and to reward proportionately the workmen who do make the profits.

It was not the thousands of employees of the United States Steel Corporation who urged that they might be given opportunity of becoming shareholders in the company; on the contrary, the plan for enabling the men to participate in the profits of their work was arranged entirely by the administration, and accepted by the men as individuals, after a most sullen reception by the labor organizations.

Again, it is well understood by the modern successful corporations that reductions in the cost of the finished product are made, not by reductions in the wages of the employees, but by the increase in the output, and that foreman who is most approved by the administration is not the one who hires the cheapest men, but who knows where to get hold of high-priced men of still higher productive ability.

These are facts—facts which may be verified by those who will go, not to the old-time shop, run in the old-time paternal fashion, but to the modern establishments, operated by corporations, without souls, it is true, but with brains; establishments using modern machinery, modern high-speed tool steels, modern intensified methods of production, and, against the determined opposition of the unions, modern systems for determining the wages of the men according to their individual ability, and not by the limitations of the most inefficient members of their organizations.

It is a little curious to look back two or three years and compare the then prevailing excitement over the United States' "capture of the steel markets of the world," which was very generally supposed to be nearly impending, with the conditions since and still existing. Instead of driving the British and Continental ironmasters out of business, as certain over-excited persons seemed to expect, we have been fairly good customers for their product. Instead of flooding the markets of the world, we have not been able quite to keep pace with the enormous expansion of our own wants.

But with any let-up in the home demand export business will leap again into prominence, and it is noteworthy that Britain, at least, has never forgotten her alarm at the prospect of the American invasion, nor ceased to study her lines of defense. For this reason it is interesting to review a recent synopsis of the British iron-ore supplies.

* * *

Less than a quarter of a century ago, when it was possible to make profitable use of ores which would not now pay for the cost of smelting, the output of British ore in a single year exceeded 18,000,000 tons. Since then, however, the annual production has varied between 11,000,000 and 14,500,000 tons, which has, of course, had to be supplemented by considerable imports from other countries. Not only have districts such as South Wales, South Staffordshire, and Shropshire ceased to make substantial contributions to the sum of British raw materials, but the time seems not far distant when the same will be said of Scotland and even Lancashire and West Cumberland—the centre of the most valuable ores now raised in the British Isles.

In support of this view it has been pointed out that, since 1886, Scotland has reduced its annual output of iron ore from 1,500,000 tons to little more than 800,000 tons, while the figures having relation to Lancashire and West Cumberland are respectively 2,680,000 and 1,730,000 tons. Outside the deposits at present being worked, there is no doubt an abundance of ore left in many parts of England, notably in Devonshire and Cornwall and Northumberland and Durham, but it is questionable if, under existing conditions, any very considerable proportion of it could be utilized with profit. The ore fields of the Cleveland district are enormously rich in unexhausted supplies, but the ore, it is notorious, is of low grade and would scarcely pay for the cost of reduction. In West Cumberland, where, it is believed, there are still untouched large deposits of excellent ore, the difficulty appears to be that the veins need to be located by costly borings. There is no famine at the moment, nor is one probable in the future; all that seems likely is that Britain must more and more depend upon foreign and colonial supplies. Of these there is never likely to be a dearth, for as soon as one source of supply is closed, another will surely be opened. It is probable that for some years to come, England will continue to rely largely upon Spain, whence she now receives nearly 80 per cent. of her total imports of iron ore, and upon Sweden, Norway, and Greece. In British colonies a beginning has already been made. For several years past India has contributed considerable quantities of manganese ores. Newfoundland last year exported more than 100,000 tons of iron ore, and Australasian and South African supplies are looked forward to as possibilities of the future. But it would not seem wise for British ironmasters to place much hope upon these distant sources of supply, for in this connection freights and the future selling price of pig iron are considerations which must not be ignored.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

RAILWAY TRANSPORT IN ENGLAND AND AMERICA.

A COMPARISON OF BRITISH AND AMERICAN PRACTICE SHOWING LOCAL ADAPTATIONS TO LOCAL REQUIREMENTS.

Report of Colonel Yorke.

INTERCHANGE of ideas upon practical subjects has always been considered an important element in technical training, and it is a question whether the more modern systems have provided anything which really takes the place of the *wanderjahr,* or student journey of the German apprentice. The same idea, however, is being developed on a far larger scale at the present time in the excursions which are being made by engineering societies, by technical and industrial deputations, and by government commissioners. Such journeys of inspection cannot fail to prove beneficial both for the visitors and for the countries in which they travel, especially when the results are embodied in papers and published reports for all who choose to read.

Among important papers of this sort may be noted the report of Lieut. Colonel H. A. Yorke, R. E., to the President of the Board of Trade upon his visit of inspection of American railways, and some portions especially will be found interesting reading on both sides of the Atlantic.

One of the difficulties in preparing reports of this kind is that of conveying to the mind of the reader many things which have combined to make up the impressions upon the writer, but which cannot be described in detail. A comparison of the American method of securing the rails, using only hook headed spikes, without cast iron chairs, but with a much greater number of sleepers, and the British system of chairs and keys, and fewer sleepers, can hardly be made intelligently unless the difference in local conditions is understood. In the early history of American railways wood was plenty, and even now is much less costly than in Great Britain, while the necessity for pushing railway construction rapidly through a rough country rendered the simpler method of spiking desirable. So far as the completed way is concerned, each appears to be well adapted for its environment, and while the higher class railways of the eastern and middle states are constructed on the same general plan as the earlier roads, the liberal use of sleepers, and the excellent ballasting renders them the practical equivalent of the more complicated British system.

The whole development of American railways must be regarded from this viewpoint, and this will go far to clear up many points about which extended arguments have been held. In the United States large loads are to be hauled long distances, this rendering long trains, large cars, and heavy locomotives essential. Fortunately sufficient space was allowed for growth in the early work, the space between tracks being 7 feet in America as against 6 feet in England, while the head room under bridges and in tunnels permits a height of 16 feet 6 in. as compared with but 13 feet in England. These limitations have necessarily governed the dimensions of all structures used in connection with railway operations. Not only is this true of arrangements for height and width, since there are serious difficulties in the way of introducing wagons of great length for general service in England.

"The sidings, goods sheds, weighbridges, turntables, coal tips, screens, etc., are as a rule quite unsuitable for wagons of the dimensions named (to say nothing of the usual conditions of trade, which are based on the present style of vehicle. It is sometimes suggested that English companies should forthwith reconstruct the whole of these works and appliances, but no one has yet estimated what the cost of such alterations would amount to. It is probably incalculable, and the question arises whether, after all this vast expenditure had been incurred and the whole trade of the country had been disorganised during the transition period, the saving in handling the traffic would pay the interest on the outlay. The four-wheeled wagon will therefore in all probability remain the standard wagon of the country, and economy is to be sought in improving the design of such wagons and increasing their carrying capacity in relation to their tare, rather than in introducing wagons of greater length."

Under the conditions of traffic it is doubtful if there would be much if any advantage in using greater wagons in England. The present wagons are not generally loaded to their full capacity, and it is only for hauls of greater length than those usually occurring in Great Britain that the large car is of advantage. Coloner Yorke's report, in this respect, as in many others, but confirms the view that each system has grown up in accordance with the demands upon it, and that any wholesale change would be inadvisable on either side.

In regard to electric traction, the most important feature which Colonel Yorke found to report was the development of interurban electric railways. The relation between these and the steam railways, while at present antagonistic, will probably become settled as each finds that there is business enough for both.

"Such lines are becoming of increasing importance, population becomes more numerous in their vicinity, land values are enhanced, industrial enterprise is stimulated, and the convenience of the public is served by a frequent and cheap means of transportation, not only for passengers but also for freight. Farmers are said to appreciate the facilities thus afforded them for conveying their produce into the cities, and large quantities of milk are now daily carried into the markets by electric cars. Where steam railroads exist side by side with the electric lines, the competition between the two has been keen. Steam roads, having seen a large share of their passenger business taken from them, have made a hard fight to retain the local freight business. But it would appear that the increased prosperity and activity in a district which are promoted by the presence of an electric line result in bringing more business to the steam lines. So that while the electric lines will probably carry the local traffic—passenger and freight—for short distances, they will act as feeders for the through business of the steam roads. In other words, there is a place for each, and their interests are best served by working in harmony."

The extent to which such interurban railways could be developed in Great Britain remains to be seen. It will not do to regard them merely as extensions of street tramways; they are rather a variety of main-line road.

"Experience has proved that a substantial, well-laid track is a vital factor in the economical operation of such a road, and a large factor in its earning capacity. The question of the best type of car for such railways is still receiving much attention in the States, and has not yet been finally decided; but it is found that a heavy, substantial vehicle is necessary, and that the wheels should have deep flanges, broad treads, and strong axles."

The comparison between the American interurban railways and such examples as have already been constructed in England is strongly brought out by Colonel Yorke.

"In England the electrical interurban railways, which have been constructed under the Light Railways Act of 1896, differ in every respect from similar lines in America. They are almost invariably laid alongside the high roads, have light rails and insufficient ballast, while the cars employed on them are mostly double-decked, and have tramway wheels with small flanges. Such lines are nothing more than tramways, and quite unsuitable for high speeds. If railways of this nature are to be as successful here as they are in America, their owners must, I venture to think, profit by American experience, and follow American methods."

That such a complete and unbiased account of transport methods in America will help largely to clear up the situation in Great Britain, must be admitted. On the one hand it will go far to show that British railways are probably quite as well adapted to the traffic conditions under which they are operated as the American roads are to their surroundings. Each is the outgrowth of its environment, and only in minor details can methods be transplanted to advantage.

So far as electric traction is concerned, conditions are different. In the United States the greater rapidity with which electric traction has been developed has enabled valuable experience to be gained which British engineers would be foolish to throw aside. Mistakes have been made in many directions, but it is by those very mistakes that England may profit, if she will, to her material advantage, both socially and financially.

FLAME ARC LAMPS.

EFFECTS OBTAINED BY THE EMPLOYMENT OF CARBON TERMINALS IMPREGNATED WITH METALLIC SALTS.

J. Zeidler—Berlin Electrical Society.

VARIOUS efforts have been made of late to improve the effect and efficiency of the arc lamp, possibly because of the progress in the allied field of incandescent lighting, and in some instances there appears a similarity in the methods adopted. Originally the electric arc depended almost entirely upon the incandescence of the carbon terminals for the production of light. The carbon is vaporised, it is true, but it emits but little light, and because of its low conductivity it does not materially assist in the passage of the current. It is altogether natural, therefore, that efforts to improve the arc lamp should be directed toward the introduction of vapors of other substances. Already the Bremer arc lamp has been brought into notice, the principle upon which it is constructed being the impregnation of the carbons with salts of barium or calcium, these producing vapors of barium and calcium in the arc, adding by their incandescence to the illuminating power, and permitting, by their conductivity, the use of a much longer arc than is otherwise possible; hence the name "flame" arc lamps.

In a paper recently presented before the *Elektrotechnische Verein* of Berlin, and published in the *Elektrotechnische Zeitschrift,* Herr J. Zeidler discussed latter form for use with impregnated carbons, as made by the Allgemeine Elektrizitäts Gesellschaft, with numerous illustrations of lamp construction and action.

These lamps are intended for use with impregnated carbons, this being the essential element in the production of the flame arc, but the carbons used with them are claimed to produce no residue or slag upon the points of the electrodes to increase the resistance, the impregnating material being wholly vaporised and thus enabling a quiet, steady light to be maintained. The nature of the impregnating salts is not revealed in the paper, but doubtless they belong to the group of alkaline earth, metals, such as barium, strontium, or calcium.

Two forms of lamp are described by Herr Zeidler, one being similar to the ordinary arc lamp, the carbons being placed vertically above one another. The principal modification necessary with this form is that due to the increased length of the arc, since it is necessary to arrange for the movable carbon to be drawn back further after the current is started than is done with the ordinary carbons. In practice it is found that the steadiness of the light is improved by the use of thin carbons, presenting a small surface at the points. For this reason, and also because of the presence of the impregnating salts, the carbons are consumed more rapidly than are those of the ordinary form. This is partially provided for by making them as long as practicable, besides which double-carbon lamps, similar to those originally introduced by Brush in the United States, are employed, one pair of carbons being thrown into action only after the other is consumed.

The other form of lamp is called by Herr Zeidler an "intensive" flame arc lamp, and is constructed with the two carbons arranged side by side, forming an acute angle with each other. A forward movement of both carbons thus brings them together, while they are separated when retracted. This arrangement permits both carbons to be placed above, the arc being formed below, no shadow of the carbons being thrown down. The lamp may thus be suspended, with the enclosing globe below, being especially well arranged for the useful distribution of the light. With this arrangement it is also practicable to maintain the arc in the focus of a concave reflector, so that a large portion of the light is effectively utilized.

Both forms of these lamps are arranged for use with continuous or alternating currents, the feed mechanism being of the differential mechanical type with shunt windings, the parts being duplicated for the double-carbon lamps. The general mechanical details of the lamps appear to be well worked out, and if fuller information were given as to the material and method of impregnating the carbons the account would be very complete.

Some interesting experiments are related as to the effect of a magnetic field upon the arc, this acting to spread the arc and make it larger. Photometric measurements show, however, that no increase in illumination is produced thereby, and hence no useful purpose is served.

The economy obtained by the use of impregnated carbons is well shown in the photometric tests made with the new lamps as compared with those using the ordinary carbons. These tests are tabulated in the original paper in detail. In general it is sufficient to state that for 220 volts and 9 amperes the hemispherical intensity with the flame arc lamp was from two to three times that of the ordinary arc, while the intensive flame arc lamp gave fully four times the hemispherical intensity, using alternating current.

The colour of the light may be controlled to a certain extent by the preparation of the carbons, these being provided to give either a yellow or a milk-white light, according to the character of the impregnating material. Those for a white light, however, are not so steady as the yellow ones. The latter are best suited for indoor illumination, the former for show windows and similar public uses. Neither lamp, however, is adapted for photographic purposes, the greater actinic power of the violet rays of the ordinary arc lamp being preferable.

While the paper of Herr Zeidler is interesting as showing the efforts which are being made to develop the efficiency of the arc lamp and enable it to maintain its superiority for certain purposes over the improved forms of incandescent lamps, it is disappointing for what it does not say, and is incomplete in that it withholds any account of the materials and methods used in the preparation of the carbons. Secrecy in matters of this sort is rapidly disappearing from the work of the more progressive manufacturing establishments, dependence being placed upon legal protection for the guarding of proprietary rights, while methods are disclosed with true scientific frankness. In any case the activity of interested investigators may be depended upon to develope identical or similar processes, so that the publicity can only be delayed.

PROBLEMS IN ELECTRIC DRIVING.

SPEED REGULATION AND MOTOR CONTROL IN CONNECTION WITH CONTINUOUS AND ALTERNATING-CURRENT INSTALLATIONS.

Engineers' Club of St. Louis.

ELECTRIC driving, as applied to machine-shop tools, appears to have outgrown the point where the advisibility of using it is concerned, and the present question for discussion is not "Shall we introduce electric lighting?", but rather "How shall we introduce electric driving?" An interesting discussion before the Engineers' Club of St. Louis, published in the *Journal of the Association of Engineering Societies* brings out some practical ideas on this point from several members, and some abstract of the discussion is here given.

In the first place, the original question as to the relative economy of electrical and mechanical transmission of power appears to be a secondary matter. When electric driving was first introduced this was the main argument, but of late the greater advantage of providing each machine with its own motive power appears in the ability to operate the individual electrically-driven tool at its maximum output. Shop managers are not slow to perceive that by means of electric driving the output of individual tools may be easily doubled and sometimes trebled over that possible when all the machines receive their power from the same source. This feature is of especial importance in connection with the various plans for the increase of individual output, now being generally considered in many shops. With the advantages of the new high-speed tool steels and the incentive of premium and bonus systems of payment it is almost essential that each machine shall be capable of being driven to its maximum capacity, and since that maximum varies according to the work and the material, the necessity for an independent control of ample motive power appears. It is not a question of providing something equal to the old form of motive power, but rather the provision of a source of power capable of keeping pace with the progress of the other elements of intensified production.

Electric driving may be obtained from either continuous or alternating currents, and the best methods of applying these formed an essential portion of the discussion under consideration. For all constant service the alternating-current motor stands on an equal footing with the direct-current motor: and in view of its greater flexibility and inexpensive maintenance the alternating-current motor possesses certain advantages. At the same time no entirely satisfactory system has yet been devised by which speed variation comparable to that possible with the direct-current motor can be secured. It is possible that this defect may be supplied by the addition of an auxiliary mechanical speed controller, but thus far no entirely acceptable device of this sort has been produced.

Direct-current motors may be regulated as to speed in three different ways: by rheostatic control, by multi-voltage control, or by some special method, adapted for the special tool to be driven.

In the rheostatic control system the motor is of the well-known shunt type, supplied from a constant potential system of distribution. Speed variation above the normal speed of the motor is secured by the introduction of resistance into the motor shunt field circuit; speed variation below the normal is obtained by the introduction of resistance into the armature circuit. When armature resistance is used for speed reduction, however, the efficiency of the motor is lowered, while the speed will vary for varying loads. This difficulty is partially met by the use of variable field resistance.

The method of speed variation by multiple voltages has been employed by various makers in various ways; the difference in voltage of the circuits providing for wide variations in speed, supplemented by the use of shunt resistance for the intermediate speeds.

Special motors are constructed by some makers, being provided with two independent armature windings which may be combined so as to produce the special speed changes desired; while in some instances storage batteries have been used.

There seems to be a general opinion, however, among the advocates of electric driving that a greater range of speed variation is required than can advantageously be secured in the motor itself. Nearly all machining operations are included under the two varieties of finishing cylindrical and plane surfaces. For the latter the speed variations are necessary only to provide for the differences in material to be worked, and these are entirely within the range of motor variation. Cylindrical work, however, requires changes in speed both for the material and for its diameter, since the same rotative speed gives lineal speeds varying with the size of the work. To provide for such a great number of speed changes thus required for lathes, boring mills, and similar machines is more than can properly be demanded of the motor alone, but it may readily be accomplished by a combination of mechanical and electrical means.

An important element in the selection of motors and methods for driving machine tools is the nature of the maximum load. In most machines of a reciprocating nature, such as slotters, planers, shapers, and the like, the power is largely consumed in the reversals of the machine, varying with the speed, and affected in a minor degree only by the actual work being done. In cases of this kind the motors should be specified to run on full field, full voltage at the maximum speed required, the speed variation being obtained by use of multi-voltage circuits and shunt field resistance for intermediate speeds, no resistance being used in the shunt field of the motor when the motor is operating on full voltage.

There is every probability that ultimately the alternating system will be generally used for machine shop driving, and the experience of the firm of Ganz & Co., of Budapest, is cited as an example of successful work in this direction. Here standard two-phase or three-phase motors are used, wires from two generators furnishing fifty and twenty-five cycles respectively, are taken to each motor. On the higher frequency the motor runs without transformer; on the low frequency a transformer is inserted, reducing the voltage to a point where the best efficiency is obtained in the motor. At the Oerlikon Works, in Switzerland but one set of wires from one generator is taken to the motors. The motors are made with short-circuited armatures and two sets of field winding, one with double the number of poles of the other. A combination of these two systems it was suggested, might give all the advantages of the best multiple voltage control system, dependent, of course, upon cost and electrical efficiency.

This whole subject of electric driving is broadening out in a way which could scarcely have been foreseen. Realizing that by far the greatest element of the cost of the product lies in the wage of the workman, and in full view of the fact that wages have a continual tendency to increase, the works manager has seized upon the possibilities of independent driving to aid him in sorting out the men and methods of greatest productive capacity, and in lowering costs by increasing output per man and per machine. Viewed in this light, all comparisons as to the cost of transmitting power by mechanical and electrical methods become unimportant, and thus the whole subject is cleared up in a manner which cannot fail to aid in its intelligent consideration.

PREMIUM WAGE-SYSTEMS.

DETAILS OF THE PRACTICAL OPERATION OF THE ROWAN MODIFICATION OF THE PREMIUM SYSTEM IN A MARINE ENGINEERING WORKS.

Institution of Mechanical Engineers.

IT appears now to be fairly well settled that some sort of an arrangement whereby the wages of a mechanic should be proportioned to the performance and the output, as well as the time, is a practicable way of settling a most important element in the labour problem. For this reason the paper of Mr. James Rowan, recently presented before the Institution of Mechanical Engineers, dealing with the success which he has met in introducing a modified form of the premium system in his own works, forms most interesting reading, and it should lead to a trial of the experiment in numerous other establishments.

Broadly, the premium system, as described by the originator, Mr. F. A. Halsey, in his paper before the American Society of Mechanical Engineers in 1891, consists in setting a time for each job of work, within which time limit the workman is supposed to be capable of completing it without difficulty. For all the time inside this allotted limit saved by the workman a premium is paid to him, this being an inducement to him to complete the work in less time than the original allotment. If, however, the time limited is exceeded the workman still receives the regular time rate of wages to which he has been accustomed. According to Mr. Halsey's plan, the workman's premium is a time allowance of one-half the time saved by him over the original number of hours fixed for the job. According to another system, also used in the United States, a determinate bonus is paid to the workman for completing the job in less time than was allotted to him, while according to the system described and used by Mr. Rowan, the premium is made proportional to the ratio between the time saved and the man's wages. In any case, the fundamental idea is the same, namely, to interest the workman in the rapid completion of the work by enabling him to share in the gain thus effected. It will be seen that a most important element in the success of any such system lies in the fixing of the time limits upon the various jobs, and Mr. Rowan's practical experience in this matter renders his paper especially interesting. Says he:

"Before deciding to introduce the premium system the following points should be well considered, namely, the amount of personal work involved, the prospective expenditure of capital, the perseverance required on the part of the management to maintain it, and the initial outlay on the rate-fixing department. It is only by the most assiduous attention and the utmost perseverance that it will be successfully carried through. It should never be allowed to be a failure. It would be better not to attempt it, if there is any chance of failure, and it certainly should not be introduced into any workshop hurriedly or before arrangements are thoroughly made.

"The first thing to be done by a firm introducing a premium system is to establish a rate-fixing department. It is of importance that a separate department be started, and that the rate-fixing be not placed as an additional duty upon the foreman. No one need be alarmed at this, as two men will do all the rate-fixing that is required in an engineering workshop employing about 300 men. In a very short time the rate-fixing, time keeping and wages-costing departments will merge into one, as the work done is so much allied. Two men, with the assistance of two timekeepers and two boys, will do all the work that is required, until the wages are abstracted and invoiced against the different jobs. The man in charge of the rate-fixing department should be a trained engineer with a good deal of workshop experience and some experience in the drawing office. An intelligent man, with this training, soon gains the confidence of the workmen, and in a short time is able to fix time allowances with wonderful accuracy, and his practical experience is of great assistance.

"It is essential to have data as to the times taken by the men at the various jobs when working on time wages, before the premium system can be introduced into any workshop, and the following hints may be useful. Let it be assumed that the workshop has been working on time, and that the times to do the various operations have been taken in detail by the timekeepers or recorded in some manner by the men themselves, as is done in many workshops, or where the work is large, such as marine engines, electric-light engines, etc., that the times to do all the operations have been recorded against the contract as a whole. It may be considered by some employers that the times as thus taken by their timekeepers, or recorded by the men, afford them sufficient information to start upon. Too much value, however, should not be attached to these times, and they should not be used as a basis for fixing time allowances."

The data gathered previous to the introduction of the premium system should relate not only to the standard work of the establishment under consideration, but also to the various elements of the operations, since the possession of this information enables new combinations to be made in determining the rates for fresh operations. This information may then be arranged for subsequent use, so many holes of a given size per hour being allowed, or so many minutes per inch diameter of flange. In the United States it is not uncommon for certain operations to be reduced to mathematical formulas, by which new combinations may be readily calculated, and this side of the question, among others, will be found discussed in the paper by Mr. Colwell, elsewhere in this issue. Special slide rules are sometimes used for such computations, but in all cases much must depend upon the judgment of the rate fixer.

It has been Mr. Rowan's experience that in most cases the time taken to do any piece of work can be reduced, although it may require capital expenditure, together with the assistance of education and intelligence. This is, of course, common knowledge, but it may be questioned if the best use is made of this knowledge, except in workshops where a number of machines are employed in doing identically the same class of work. No doubt, in these workshops great attention is concentrated on the machines, with the result that their output is good, but where the machines are employed doing a variety of work, as in the manufacture of large engines, it is very hard to tell whether the time taken to do the work is good or bad. If, however, the time taken to do the work is down in black and white, and repeated again and again, the management should ultimately have no difficulty in deciding whether the work is done in good time or not. In estimating time allowances, after the system has been working for a period, there is nothing so useful as a comparison of the times allowed for similar jobs, and there is no question as to the value of this comparison, more especially in jobs which require considerable setting and some degree of skill and intelligence on the part of the workmen, and where the time the machine is cutting is only a minor part of the time actually required for the job. Data accumulate very quickly, and soon, no matter what job comes along, the rate-fixer can estimate a suitable time allowance for it which will be fair both to employer and workmen.

In the process of establishing time allowances, errors may be made, and it may be found necessary to either shorten or lengthen the times first tried, and every precaution should be taken to avoid the necessity for such changes by fixing time allowances as carefully as possible. It is also essential for success that anyone adopting the premium system should deal in all fairness when fixing time allowances.

Mr. Rowan shows that the introduction of the premium system into his establishment has resulted in the reduction of the times of all the machinemen during four years by 20, 23, 31, and 37 per cent., with a proportional increase in the men's earnings. The men are thoroughly satisfied with the system, and have no desire to return to the time method, and apparently all is satisfactory on both sides.

The most important element to the employer apart from the increased capacity given to the shop lies in the proportional reduction in establishment charges, these remaining a constant total to be divided up over a greatly increased output. This is a gain which cannot be too highly estimated, since the general expense account has always been one of the difficult problems in successful works management. The increased interest among the workmen also stimulated is most valuable, all alike looking to the use of tools, materials, and methods which will facilitate their work and enable them to earn larger premiums.

Many men have argued against the practicability of such systems, and such objections have come from both employers and workingmen, but the records of Mr. Rowan and many others who have had success with the premium system form the best reply which can be made to such objections.

THE UTILISATION OF TIDAL ENERGY.

A DICUSSION OF THE PRACTICAL DIFFICULTIES IN THE WAY OF THE APPLICATION OF THE ENERGY OF OCEAN TIDES.

Canadian Society of Civil Engineers.

AMONG the various sources of natural energy the ocean tides have often been considered as a practicable possibility, although up to the present time, with the exception of a few small tide mills, no actual installation of machinery for the purpose has been made.

It is a question, however, whether the practical obstacles to be encountered may not make such power cost nearly as much as it is worth, and this phase of the subject is examined in a paper presented before the Canadian Society of Civil Engineers by Mr. C. P. Baillairge.

The most apparent difficulty in connection with the utilisation of the power of the tides appears in the irregularity of the movement. Not only does the tide rise and fall twice every twenty-four hours, but the range of rise and fall is continually varying, so that there is not only the lull at high and low water, but also the difference between spring and neap tides to be considered, all of these rendering the direct utilisation of tidal energy impracticable for any except a very limited number of industries. The most obvious method, therefore, of utilising the tides involves some such regulating method as the retention of the high water in some kind of a reservoir, the flow from this reservoir being used between tides to operate turbines or similar water motors. Such tidal reservoirs are seen in the docks at Liverpool and elsewhere, and their construction is entirely practicable, although some regulating mechanism would be necessary, such as the throwing into action of an increasing number of turbines as the head of water diminished in order to mantain a fair degree of unformity in the amount of power developed, but such details appear to be feasible.

Another method, and one which has been suggested with numerous modifications, is that of a float or pontoon, rising and falling with the tide, connected with some fixed point by means of a beam or similar device, through which the power may be transmitted for conversion into rotary or other form of motion.

Both of these devices, however, are subject to another practical objection, namely, the slowness of the tidal movement. Thus, if we take a location in which there are tides averaging twelve feet, we have twenty-four feet of movement per tide, or per twelve hours, the equivalent of two feet per hour, and although this vertical movement extends over the whole body of water, it must be converted into some more rapid motion before it can be made available for operative power purposes. Mr. Baillairge examines the multiplication of the speed by means of gearing, and shows that even with a very moderate allowance for frictional losses fully 75 per cent. of the power would be absorbed in speed multiplication. Of course it might be practicable to impound a large reservoir of water at high tide and hold it back until the period shortly before and after extreme low tide, and discharge it all in that brief period through turbines at a practicable rate of speed, but the energy would then be available for but two short periods every day, and its uses materially limited, except for charging electrical storage batteries or similar work.

All the plans which have been advanced for the utilisation of the energy of the tides appear to have assumed that a vast amount of power is readily available, if only suitable machinery can be devised to harness it. It is therefore interesting to examine the computations of Mr. Baillairge as to the actual amount of power to be had from any given example. Apparently it is an almost irresistible power, since with the tide everything rises upon its surface even to a twenty to thirty thousand ton ship, and in a similar manner it would lift a whole city if built on a water-tight bottom or pontoon with depth of water sufficient to allow it to sink until the weight of water displaced were equal, as with a vessel, to the weight supported.

Such ideas, however, are deceptive, since the real work performed by the tide is measured, not by the weight of anything floating upon it, but by the actual weight of the water and the distance through which it is lifted. Thus, if we take a square foot of surface, and a tide of twelve feet, we have for the work performed by its rise and fall the weight of twelve cubic feet of water raised to an average height of six feet, or about 4,500 foot-pounds in six hours; this corresponding to 12½ foot-pounds per minute for a square foot of water area with a tide of twelve feet, or approximately, about one foot-pound per minute per square foot of surface for every foot height of tide. Since one horse power is equal to 33,000 foot-pounds per minute it would take 33,000 square feet to give a horse power with a one-foot tide, or with a twelve-foot tide 2,750 square feet per horse power.

In order to obtain a concrete example of what this really means, the Liverpool landing stage may be considered, this being 2,063 feet long, by 80 feet wide, and therefore 165,040 square feet area. With a 25 foot tide, such as is found at Liverpool, this gives 4,126,000 foot-pounds per minute, or 125 horse power.

We see, therefore, that any apparatus to utilise the power of the tides by means of floating pontoons involves very bulky apparatus, and it is a question if the interest on first cost and the expense of maintenance and repairs would not form a very formidable charge upon the cost of the power. Similar computations may be made for the area required for impounding the water in reservoirs, and although less mechanism might be required, the value of land by a tidal river, or the cost of dams and reservoir walls necessarily involves large fixed charges to be borne by the power developed.

While there is therefore undoubtedly a vast amount of power existing in the movement of the tides, it lacks in what may be called concentration, and except in certain favored localities, where the configuration of the land provides natural basins which may readily be arranged to impound large areas of water, the cost of harnessing and regulating this power must be excessive. The popular idea estimates the power of the tide by observing but a single element, the weight of water elevated, failing to realise that the other elements of which power is composed, namely, time and distance, are so disproportionate as to render the actual power developed much less than really appears. The weight of water elevated has to be multiplied by the distance, which is small, and divided by the time, which is large, and it is only by taking the latter elements into account that a true grasp of the problem is to be attained.

THE RESISTANCE OF THE AIR.

THE EXPERIMENTS OF CANOVETTI UPON THE RESISTANCE OF THE ATMOSPHERE TO BODIES OF VARIOUS SHAPES IN MOTION.

Report of the Société d'Encouragement.

WE have referred already in these pages to the interesting and valuable experiments which have been made upon the resistance of the air by M. le Dantec, and also by M. Canovetti, and now we have the very complete report by M. Barbet, representing the Comité des Arts Mécaniques of the Société d'Encouragement pour l'Industrie Nationale upon the later work of M. Canovetti, published in the *Bulletin* of the society.

These experiments, which were made at Brescia, have already been discussed by the society and in accordance with the report previously presented, M. Canovetti has been awarded a gold medal for his researches. As a consequence of the importance of the work accomplished by M. Canovetti, the Société d'Encouragement appropriated the sum of 1,000 francs to aid in the continuance of the experiments, and a like sum was furnished by the Smithsonian Institution at Washington through the Secretary, Professor Langley.

The present report includes these subsequent investigations extending the scope of the previous work.

It is generally conceded by experimenters that the resistance opposed by the air to moving bodies is proportional to the area opposed by the wind and also to the square of the speed of motion, and the present object of inquiry is to determine the co-efficient expressing this proportionality.

The general construction of the apparatus with which the investigations were made will be readily understood. A copper wire, 380 metres in length was stretched from a point on the fortifications of Brescia to another point about 70 metres below, thus forming a long inclined catenary. Upon this wire a light carriage, made of aluminum tubing, was arranged to travel upon grooved wheels, these wheels being fitted with ball bearings, and every precaution being taken to reduce the frictional and other resistances of the carriage to a minimum. The body of which the resistance was to be tested was suspended to the carriage, the connections being of wire, so arranged as to maintain rigidity, and at the same time add an inappreciable amount to the weight and resistance.

It is evident that with such an arrangement, if the carriage and its surface offered no resistance, the velocity attained at any moment would be that due to the fall. In fact the observed velocity is always less than would be that of a body falling from the same height. This is partly due to the frictional resistance of the carriage but principally is caused by the resistance offered by the air to the surface attached to the carriage. At the beginning of the fall the speed increases, but since the resistance of the air increases with the speed, the velocity is gradually checked until the two forces balance each other, after which the motion becomes uniform. The resistance of the carriage having been determined by preliminary trials this portion may be deducted, and the remainder represents the resistance opposed by the air to the surface under consideration.

In the later experiments the length of the wire was reduced to 127 metres, while the height was nearly as great as in the earlier case, being 63.2 metres, thus giving a more rapid descent in the upper portion, and the wire was so placed as to be sheltered as much as possible from the action of the wind, the lower portion running down into a protecting trench for more than one-third of the total length. As a further precaution against the possible disturbing action of the wind M. Canovetti states that by observation of the catenary of the cord attached to the carriage for the purpose of hauling it up it was possible to perceive any lateral deflection due to wind, and under such conditions the experiments were deferred.

The results of the experiments are given in full in the form of tables, the forms of the various surfaces tested being shown by drawings, and the time required to travel a given distance after the velocity had become uniform being given in fifths of a second. From these the value of the co-efficient K in the formula for air resistance is deduced for each experiment, the results forming a mass of data in form most available for subsequent study and application.

While it is impracticable to reproduce the general results of these important experiments in this place, some of the more interesting facts may be mentioned. Thus, a circular disc exposing an area of 0.073 square metre, moving at a velocity of about 12 metres per second was opposed by an air resistance equivalent to 84 grammes, when reduced to the standard of 1 square metre moving 1 metre per second.

The same disc, when fitted with a hemispherical front piece, gave under the same conditions a value of only 21 grammes for the resistance, and when to this was added at the rear a cone of a length equal to five times the diameter of the circle, the coefficient was reduced to 13 grammes, or only about one-seventh of the original amount. When such a figure is reversed, so that the cone is in advance, the resistance coefficient became equal to 18 grammes, showing that the smallest resistance occurred with the hemispherical portion moving against the air.

While the total resistance increases almost as the square of the speed this is not absolutely correct, the value of the coefficient being found to diminish somewhat with increasing speeds. Thus for a disc of 0.80 square metre surface, moving at a speed of 4 metres per second, the value of the coefficient was found to be 88 grammes, while for the same disc moving at a speed of 7 metres, the value of the coefficient fell to 71 grammes; this confirming the observations of Professor Langley.

The report contains a number of interesting photographs indicating the manner in which the experiments were made, and the comments of M. Barbet confirm the confidence which may be reposed in the accuracy and value of the work.

HIGH-SPEED STEAM LOCOMOTIVES.

DESIGNS SUBMITTED IN THE COMPETITION OF THE GERMAN SOCIETY OF MECHANICAL ENGINEERS.

Glasers Annalen.

PROBABLY as a consequence of the attempts to attain extraordinary high speeds upon the experimental electric railway between Marienfelde and Zossen, the Verein Deutscher Maschinen Ingenieure instituted in March, 1902, a competition for designs for high-speed steam locomotives, the competing plans to be examined in December of the same year. In a recent issue of *Glasers Annalen* the report of the judges is made public, and in a subsequent issue detailed illustrations are given of some of the engines, and we find some interesting features about the machines for review.

There were in all thirteen designs submitted, and in the opinion of the judges no one of these was deemed worthy of the entire award, hence five of the competing plans were given premiums of 1,000 marks each, and the competition was continued between the recipients of these premiums.

The designs published in *Glasers Annalen* bear a close similarity in general appearance, differing, however, in details of construction. In general, they bear a remarkable resemblance to the so-called Atlantic type, used for express locomotives in the United States, having a swivel truck under the smoke box, two driving axles forward of the fire box, and a truck below or behind the latter. Large driving wheels are thus made possible without preventing the use of a wide grate, the fire box extending over the frames, much in the style of the Wootten engines, used for many years in America. The designs show an appreciation of the fact that the possibilities of high speed lie, to a great extent, in the steaming capacity, the boilers being as large as the space limitations will permit, both as regards heating surface and grate area.

The advantages of compounding for high-speed appear to have beyen considered differently by the various designers, one engine being a four-cylinder compound, two are three-cylinder compounds, and the fourth a four-cylinder high-pressure machine, the number of cylinders being multiplied for the purpose of balancing. In view of the fact that the limitations to high speed lie largely in the steaming, it appears that the economical use of the steam in the engine practically corresponds to an increase in boiler capacity, and that compounding must necessarily be included for the maintenance of continuous maximum speeds. Experience in France with the engines on the De Glehn system, and in the United States with the Vauclain compounds seem to confirm this view.

In all the designs submitted the question of air resistance seems to have been considered, at least to the extent of providing conical, or prow-shaped outlines to the forward end of the engine, one design going so far as to enclose the entire locomotive in a sort of casing to provide a smooth exterior surface. While the head air resistance may be somewhat reduced in this manner, yet it is a matter of experience that a slight wind on the quarter, crowding the flanges of the wheels against the side of the rail, is a much greater hurtful resistance, and one which is increased with any increase in the area upon which the wind can act.

In one respect an important innovation is advocated. With the large boilers and wide fireboxes of modern express locomotives it has been found necessary to place the engine driver's cab upon the locomotive, this in many cases separating him entirely from the fireman. In some recent designs this idea has been carried out to its natural conclusion, that of placing the driver's cab in the very front of the engine, thus giving him a clear and uninterrupted view of the road, but at the same time separating him from the fireman by the entire length of the locomotive, and rendering communication difficult or even impossible. In one of the designs submitted in the present competition, however, the whole arrangement is reversed, the cab for both driver and fireman being placed at the firebox end of the locomotive, this being made the forward end of the machine, the engine being intended to run backward, according to the existing custom of speaking. There is not the slightest reason why one end or the other of a locomotive engine should be considered as the forward end, and the designer should certainly be left free to choose either, as he may elect. The small locomotives on the elevated railway in New York city are operated indifferently in either direction, while the double ended engines on the Mallet system are necessarily always with one smoke stack in the rear. In this matter, as in various others, convention has doubtless had much to do with the usual defective arrangement in which the engineer is obliged to peer around the greater portion of his machine to obtain but a partial view of the track before him.

Broadly speaking, the designs submitted in the competition show little or nothing new. Large, powerful locomotives, capable of maintaining speeds of 120 kilometres per hour (about 75 miles an hour) have already been built on the same general lines as those submitted in this competition, and the fact that little new has been brought out shows that the limitations in steam locomotive design may already be closely approached. As a matter of fact there must be natural and physical limits to the possibilities of construction of a traveling power house. Apart from the limitations to the dimensions of the boiler there appears the question of the capacity of human effort in stoking the large grates at the rapid rate of combustion demanded. Already in the United States attempts have been made to use two firemen, simply because the powers of endurance of the strongest stokers are singly unequal to the demand, while mechanical stokers for locomotive engines are being discussed, some forms having already been produced because of the heavy requirements and the impossibility of maintaining a sufficiently high rate of combustion with hand firing. In this respect there is no doubt that liquid fuel affords great advantages, and its use will permit a higher rate of combustion and far greater ease of manipulation.

As a matter of fact, however, the whole question of speed limitation at the present time lies, not in the locomotive engine, but in the permanent way. It is altogether possible to attain speeds of more than 120 kilometres per hour either with steam or electricity as the motive power if the road bed be made equal to the task. This was found to be true in the trials between Marienfelde and Zossen, the motor cars there being obliged to keep below their maximum speeds because of the dangerous vibrations caused by the condition of the track. If extremely high speeds are desired it will be necessary to lay much heavier rails, to provide more solid way, to secure practically perfect alignment, in both horizontal and vertical planes; in short, to remove all external causes of vibration. When, on track of such a character, the maximum speeds of the existing forms of locomotive, both steam and electrical, have been demonstrated it will be time to provide new designs, but not before.

COMPRESSION IN STEAM-ENGINE CYLINDERS.

A COMPARISON OF THE TESTS WITH VARYING COMPRESSION AND THE RESULTS OBTAINED IN PRACTICAL WORKING.

C. L. Browne—Electrical Engineer.

SOME time ago we referred in these columns to the experiments of Professor Dwelshauvers-Dery, at the University of Liége upon the deleterious influence of high compression upon steam economy. These investigations attracted much interest at the time, and were followed by other at various places, it being felt desirable to confirm or refute results contrary to the expressed opinion of such a high authority as Zeuner, as well as opposing the practice of many eminent designers and constructors. In a recent article published in the *Electrical Engineer,* Mr. C. L. Browne collects the results of the experiments of a number of scientific observers upon this question and compares their results with the conditions actually obtaining in practice, giving an interesting view of the whole situation.

The experiments of Professor Dwelshauvers-Dery, made upon the experimental engine at the University of Liége, showed that the steam consumption increased when the compression was raised from 10 to 20 per cent. Further experiments proved that when the compression was increased to 30 per cent. the steam consumption rose 21 per cent., while with a compression of 40 per cent. the quantity of steam required increased more than 50 per cent. over that with no compression. With a condensing engine the losses following upon increased compression were not so great, but the general action was similar.

Experiments made by Doerfel at the Radotin Cement Factory gave corresponding results, the losses following upon increased compression more than counterbalancing the amount of steam saved by the earlier closing of the exhaust port. In these experiments the important observation was made that the condensation losses varied largely with the wetness of the steam used. Some very careful experiments made at the Stevens Institute of Technology, in the United States, by Professor Jacobus showed a slight increase in steam consumption with increased compression, and similar results have been obtained by Professor Carpenter at Cornell University, but in neither of these series of experiments were as large losses found as in the experiments in Belgium and in Germany.

After examining these results, Mr. Browne asks the pertinent question: "How far do these figures represent the results which may be expected to accompany the compression of the cushion steam in modern steam engines? Or, in other words, do the conditions which obtained in the above trials represent those to be met with in everyday practice? The obvious answer is, generally speaking, they do not. Instance the case of the engine used by Dwelshauvers-Dery in his first set of trials. The cylinder was only 12 inches in diameter by 23.9 inch stroke, with a clearance volume of 7.9 per cent., and clearance surface area of six square feet, admission ceasing at one-tenth of the stroke. The temperature range during one stroke was apparently about 180 degrees F. Under these conditions it might have been confidently predicted that excessive condensation would take place in the cylinder, since the harmful influence of the cylinder walls would be out of all proportion with the volume of the working steam. The excessive high steam consumption—in one case reaching nearly 56 pounds per indicated horse-power hour—is indicative of the extreme conditions under which the results were arrived at."

In the case of modern steam engines of large power the volume of steam in the cylinder is many times greater than the "wall area" of the engines used in the laboratory tests, and hence the amount of cylinder liquefaction is proportionately reduced. Even in such cases, however, the whole of the work expended in compressing the exhaust steam will not be returned during expansion on the next stroke, since it depends upon other factors, including the difference between the pressures of release and exhaust respectively.

In all cases, however, the action of the cylinder walls is most important, and although not appearing upon the indicator diagram, it has a great influence upon the efficiency of the engine. This will be realised by a consideration of the action going on in the cylinder.

"When the admission valve opens, the steam rushes into the cylinder and strikes against the metallic surfaces of the cylinder and piston. When not originally superheated, the condensation of from 20 to 60 per cent. of the admission steam is the result. As the point of cut-off is reached and expansion commences, more of the chilled wall of the cylinder is uncovered by the piston and a further quantity of steam is liquefied until a point is reached where the fall in pressure causes the layer of water deposited on the metal surfaces to be re-evaporated, and this process continues until the exhause valve opens, and in some cases continues during the period of exhaust. On the exhaust valve again closing, the cushion steam being compressed into the clearance spaces, its temperature at first rises, partly owing to the fact that work is being done upon it, and partly to the heat given by the cylinder walls, the temperature of which is higher than that of the enclosed steam. Immediately, however, that the steam attains a temperature in excess of that of the surfaces which surround it, a layer of water is again formed, and the exaltation of the compression curve on the indicator diagram becomes less rapid in proportion to the decreasing volume of the steam."

Mr. Browne shows that large losses may be expected from high compression when there is a wide temperature range throughout the stroke; when there are large clearance surfaces; when there is early release, and when the steam is wet. All these are wasteful conditions in any event, and should not be permitted if they can be avoided, so that it is hardly proper to condemn compression when tested under conditions of general wasteful operation. When, however, the clearance is small, a moderate degree of compression is found to produce no appreciable loss, and at the same time it may be found advisable in order to insure smooth running.

THE IMPROVEMENT OF CUMBERLAND SOUND.

SUCCESSFUL DEEPENING OF A TIDAL HARBOR ENTRANCE BY MODERN METHODS OF JETTY CONSTRUCTION.

J. H. Bacon—Engineering News.

VERY often the most successful work of the engineer is found to lie in the direction and utilization of forces which, uncontrolled, are producing the very opposite effects to those which are desired. This is especially true in operations of harbor improvement and the production of navigable channels. In some cases recourse to mechanical methods of removing obstructions, such as dredging, must be had, but unless these are used in connection with the control of the action of winds and currents the effect can be but temporary.

An excellent example of the manner in which the action of tides and currents has been utilized to produce and maintain a deep channel is seen in the harbor improvement works at Cumberland Sound, the entrance to the port of Fernandina, Florida; and an account of the work which has there been successfully done under the direction of Captain C. E. Gillette is given by Mr. J. H. Bacon in a recent issue of *Engineering News*. This work is interesting also because its location may be considered typical of most harbor entrances on the south Atlantic coast. The characteristics of the site are well described by Mr. Bacon.

"A deep gorge, known as Amelia Basin, extended from the inner sound out between Cumberland and Amelia islands, for a distance of about one-half mile from the latter, and has continued essentially unchanged for many years. At its seaward end occurred the shifting of the channel so common on this coast. The direct course to the northeast across the bar was, at irregular intervals, slowly deflected southward by the encroachment of the sand coming from the north, until its increasing length became too great for maintenance when (usually in some storm) the outflowing tide again forced a new channel straight across the bar, and the same cycle of changes was again resumed."

Under these conditions the available depth on the bar at mean low water was about 12 feet, while the rise and fall of the tide is 5.9 feet. The absence of any material aid from the St. Mary's river rendered it necessary to protect the channel from this sand drift and to utilize the action of the tide to produce the scour to create and maintain a navigable channel, and the works recently constructed appear to have accomplished that end far more successfully than their predecessors.

After referring to the incomplete and disintegrated remains of the inefficient work done on the site prior to 1900, Mr. Bacon proceeds to describe the manner in which the present jetties have been constructed and to show how the results have been attained. The original plans provided for two jetties, the north one extending from Cumberland Island seaward for a length of about 3¾ miles; while the south jetty, about three-quarters of a mile further south, was to extend from Amelia Island outwards, the relative positions of the two islands making the south jetty only about half as long as the north one.

The defects of this plan were seen by some at that time, and in the report of the resident engineer in 1891 it was stated that "should the channel be protected on its northern side by a training wall there will also be gained such concentration of flow along the concave curve as may, and probably will render a southerly training wall superfluous. The adoption of this plan would necessitate the removal of the central portion of the southern jetty, where two courses have been laid." This recommendation if followed, would have resulted in reducing the cost of the works by one-half of the original estimate.

This plan, essentially that of Professor Lewis M. Haupt, was not approved by the Board of Engineers, and accordingly work was continued upon the two jetties, with the result of filling the channel with sand, rendering a breach in the south jetty necessary to permit vessels to enter the port.

When the work was resumed, in 1900, under a new contract, it was begun upon the outer end of the north jetty, and thus a barrier was placed against the prevailing drift of the sand to the bar crossing and at once the currents were aided in restoring their natural channel.

The result to-day has been the formation of a channel close under the lee of the jetty, the depth increasing naturally from 6½ feet to 14 feet, after which it was increased by dredging to 20 feet. The dredging was resorted to only to accelerate the work, and since it was discontinued the channel has still further increased in depth to 21 feet, showing the scour of the tide to be sufficient to maintain the channel without other artificial aid than that afforded by the cover of the jetty. Practically all of this deepening has been produced by the action of the tide against the single north jetty, the reconstructed south jetty having been completed to only about one-quarter of its length from Amelia Island seaward by December 1902, at which time the 21-foot channel had been fully established.

The magnitude of the work which has thus been accomplished will be better appreciated when it is understood that during the period between June, 1900, and June, 1902, 1,056,000 cubic yards of sand were moved from the sections through which the channel passed. "Of this amount 102,000 cubic yards were removed by dredging, leaving a balance of 954,000 cubic yards that were moved by the scouring action, due mostly to the north jetty."

Mr. Bacon's paper is accompanied by reproductions of several hydrographic charts made at successive dates, showing clearly the action of the north jetty in producing the new channel. Since all of these were made before any appreciable amount of work had been done on the reconstructed south jetty they may be taken as indications of the effect which may be produced by a single jetty placed to windward of the channel to be created.

It is therefore interesting to compare the results which have been obtained at Cumberland Sound with the theory and requirements of the reaction breakwater, as advocated by Professor Haupt, in 1888, and discussed in our review of his recent paper before the American Association for the Advancement of Science in these columns a few months ago. Thus Professor Haupt advocated a single jetty, placed between the channel and the source of prevailing drift, the jetty to be raised above the highest tide, and constructed inwards beginning on the outer slope of the bar, the form gradually curving towards the axis of the ebb current so as to maintain a continuous reaction and consequent scour along its concave face.

An examination of the maps of the work at Cumberland Sound shows that practically all these conditions were closely followed in the location and conduct of this work, with the single exception that the jetty was made angular, instead of being curved. The maps show also, however, that the channel itself took the reversed curved form advocated by Professor Haupt, clearly indicating the path of the scour, and showing the nature of the tidal action. It is not often that such a striking confirmation of theoretical principles appears in a practical instance in which the original intention was guided by altogether different considerations.

The curious thing about the work at Cumberland Sound is that it is thought necessary to complete the south jetty when the work has already been done by the action of the single north jetty. The channel having been made, and the scour continuing to maintain its depth, it seems like an unnecessary expenditure to proceed with a portion of the work so evidently superfluous. At least the lesson which has been learned in this instance may serve as a guide for future works elsewhere, and obviate the necessity for the construction of useless work in other harbor entrances.

HERTZIAN WAVE TELEGRAPHY.

LECTURES BY PROFESSOR FLEMING UPON THE PRESENT STATUS OF THE ART OF TELEGRAPHING THROUGH SPACE BY MAGNETIC WAVES.

Society of Arts.

PROGRESS in the development of space telegraphy is so rapid that one must watch carefully in order to keep up to date with the latest improvements, and for this reason, among many others, the lectures recently delivered by Professor J. A. Fleming before the Society of Arts will be welcomed.

Starting out with the statement that the problem of telegraphing through space lies in the production of electric waves in the ether and in their reception at a distance, Dr. Fleming proceeded to take up the successive stages of the operation, beginning with the aerial radiator, and following with a discussion of the transmitting apparatus and the receiver, concluding with an account of the various methods devised to insure privacy and to guard against interference.

As an interesting analogy to the radiating vertical wire, used by Marconi, Dr. Fleming referred to the action of a siren, emitting acoustic impulses into the lower part of a vertical organ pipe, which thus emits a note, the waves passing off through the air to impinge upon the ear of the listener. In like manner the discharge across a spark gap may be employed to send electrical impulses up into a vertical wire, from which magnetic waves are propagated out through the ether. In order to explain the manner in which the waves are produced it became necessary to enter into some account of the modern theory of electrons, and the state of strain in which their motion places the ether, and this difficult portion of the subject was made clear to a general audience by some analogies of a mechanical nature.

Retaining the analogy of the vertical radiating wire and the organ pipe, Dr. Fleming proceeded to discuss the various transmitting devices by comparison with the methods which might be employed in setting up sound vibrations in the pipe. Thus the siren involves an air compressor, producing pneumatic pressure, the discharge of which, when rhythmically interrupted, starts sound waves in the organ pipe. In like manner an induction coil or an alternating-current transformer is used in space telegraphy to produce the electrical discharges, this corresponding to the air compressor, while some form of interrupter is employed, just as in the case of the organ pipe the interruptions are effected by the siren.

The various forms of interrupter used in space telegraphy, reviewed by Dr. Fleming, include the older type of hammer break, followed by different kinds of mercury interrupters, and also the electrolytic interrupter of Wehnelt. Mention was also made of the use of the Cooper-Hewitt mercury-vapour tube as an interrupter, but this apparatus has as yet not been practically tested in connection with space telegraphy.

As, in the case of the air compressor and siren, some form of air reservoir is necessary, so in the case of electric wave production a condenser is required. The whole operation of transmission, therefore, includes the production of pressure, storing it up, releasing it in the spark gap, and producing the oscillations in the aerial radiating wire. The waves thus sent out through the ether require only a suitable receiver, analagous to the human ear in order that the complete transmission may be effected.

Of the first and earliest type of receiver, the coherer, based on the early observation of Varley, Onesti, Branly, and others, Dr. Fleming illustrated several examples, including tapping devices for decohering; and followed with descriptions of the mercury-drop ether, the magnetic detectors of Rutherford and of Marconi, the electrolytic receiver of De Forest, and the thermal receiver of Fessenden.

In this connection we may note the new word, "kumascope," coined by Dr. Fleming, to express broadly a receiver for magnetic waves in space telegraphy, there being such a variety of devices at present under consideration as to render the earlier terms either too narrow or too broad. Whether this particular term will survive or not remains to be seen, but that some equivalent word is desirable will be admitted.

Since it is desirable that the wave messages received should also be recorded, most of these devices are arranged to be used with a recording tape, much in the manner of the Morse telegraphic recorded, but Dr. Fleming maintains that there is no apparatus so sensitive for the detection of electric waves as the telephone and the human ear, although it is possible that a visual receiver may be used to advantage. When it is remembered, however, that by far the greater number of Morse telegraphic messages are already received by sound, there appears to be no very good reason for desiring to improve on that method merely because the transmitting system is a different one.

Probably the feature in magnetic space telegraphy which is now attracting the most attention is that of the possibility of devising practical selective methods, in order that a transmitter and receiver may be so tuned to each other that the receiver shall reject all messages except those intended for it. That some such arrangement is essential to the commercial success of the system appears positive, not because secrecy may not be attained by the use of cipher codes or similar methods, but because, with the multiplication of stations and message the interference must be prevented if a hopeless jumble of waves is to be avoided. The ability to tune transmitters and receivers to each other appears to be proved by some recent experiments made by Dr. Fleming and Mr. Marconi, in which simultaneous communications between Poldhu and the Lizard were maintained, using both the powerful transmitter, employed for transatlantic service, and a much weaker one arranged for communication with channel steamers. No interference took place whatever, and since great precautions were taken to observe secrecy as to the contents of the messages, the absence of any collusion between operators were assured.

As a matter of fact, however, it is not so much the question of secrecy as that of interference, which is to be considered. A powerful transmitting station, it is admitted, may disturb the service of other stations if the latter are not so tuned as to be irresponsive, and thus there is a real need of some system and agreement among operators and stations, otherwise confusion is certain to result. Intentional disturbances undoubtedly may be produced, since waves of various periods sent out in rapid succession would, to a certain extent, interfere with stations in the vicinity, and, in fact, such methods, it is said, were adopted during the last international cup races in America, and in the course of the recent naval manoeuvres in the Mediterranean.

Dr. Fleming's lectures form by far the most satisfactory popular account of the methods of space telegraphy which has yet been given, and the full publication of the text and illustrations in the *Journal of the Society of Arts* will be welcomed.

SLAG CEMENT IN GERMANY.

THE DEVELOPMENT OF THE MANUFACTURE OF CEMENT FROM BLAST FURNACE SLAG AND ITS COMMERCIAL STATUS IN GERMANY.

G. Jantzen—Stahl und Eisen.

MODERN engineering has become largely a matter of the utilisation of by-products, or rather of products which formerly were considered as wastes, but which at the present time have become in some instances as important as the former main product. Thus the former wastes of the gas works and the coke oven are now found of sufficient value, in some instances, to determine the question of profit and loss, while it is becoming a question whether the gas or the iron is the more valuable product of the blast furnace. The basic steel process includes in its valuable products the phosphate slag, the value of this product as a fertilizer in Germany alone now amounting to 25 million marks yearly.

The use of blast furnace slag in the manufacture of hydraulic cement has been increasing both in Germany and in the United States, and an important paper upon the development of the industry in Germany by Director Jantzen was recently presented before the Society for the Promotion of Technical Industries, and published in *Stahl und Eisen.*

A comparison between the analysis of furnace slag and Portland cement clinker reveals at once such a similarity in composition as to indicate the value of the former for cement making, the principal difference being one of molecular structure. When the fluid slag is allowed to run into water, however, it assumes a granular structure, after which it is finely ground and mixed with about one-fourth its volume of hydraulic lime.

Herr Jantzen reviews the historical developments of the attempts to make a slag cement in Germany, from the early experiments of Lürmann in 1862-5, down to the placing of the product on the market in 1880, since which time it has become an important commercial article. In Germany, as in the United States, there has been considerable controversy about the propriety of applying the name "Portland" to this class of cement. Herr Jantzen reviews the history of the name, showing that it was applied to the cement made by Aspdin in 1824 because of the resemblance of the product to the well-known Portland stone, and takes the position also held by some others that the name applies only to the appearance, and is not essentially connected with the composition or manufacture. At the same time it must be admitted that the name has become so closely connected with a certain class of cements that it is not correct to apply it to slag cements without some qualification to indicate the origin of the product, and indeed, in Germany the slag cements are generally known as "Iron-Portland" cements (Eisen-Portlandzement).

Some idea of the extent to which the manufacture of slag cement has grown in Germany may be obtained from the statement that there are now eleven establishments engaged in its production, and that the yearly output is about 1¾ million barrels of 170 kilogrammes each, the capital invested in the industry being about 15 million marks. A general plan of the cement department of the Buderus Iron

Works at Wetzlar shows very clearly the arrangement of a modern plant of this sort, and gives a clear idea of the extent to which by-product utilisation may develop in connection with the manufacture of iron. Data and results of a number of tests are also given, showing the resistance to tension and compression after various periods of time.

The principal characteristics of slag cement appear to lie in its slow setting and in its freedom from changes of volume. The time required for attaining full resistance is decidedly greater than for Portland cement, but after the expiration of 28 days the slag cement gave a higher resistance than the Portland cement, while the maximum strength was not attained for several months. The question of freedom from changes in volume is important, since a cement which expands in setting may be altogether unsuitable for many kinds of work.

One of the most interesting things referred to in the paper is the use of slag cement and Portland cement mixed, since the best qualities of both products may in great measure be combined. Thus a mixture of equal parts of Portland cement and slag cement sets very nearly as promptly as neat Portland cement, the respective times being 14 and 10 hours. After 28 days the strength of the neat and the mixed cements was practically the same, while after 180 days the combination of slag and Portland cements was 50 per cent. stronger than the neat Portland cement. These results appear to open a wide field for the slag cement, since a reduction in cost may be secured, and at the same time equal if not superior results attained. There is no doubt that slag cement has come to stay, and there is no reason for it to attempt to assume the name or style of existing articles, since it is amply capable of standing on its own merits.

It is interesting to examine the extending scope of the blast furnace in the light of recent developments, since it has now become not only a smelting furnace, but also a fuel-gas producer and a cement kiln, and there is a question as to which of the products may become the most important. The use of furnace gas in improved engines enables the former waste heat to be converted and distributed as electric energy, while the chemical reactions involved in the smelting of the iron and the production of gas are also employed in the formation of the slag, no longer a waste product.

The manufacture of slag cements has now become such an important element in German industry that an influential society, the "Verein Deutscher Eisen-Portlandzement-Werke" has been organised, and the acceptance of this corporate name by the Minister of Public Works establishes the term in Germany, at least, and there appears to be no good reason why it should not be used elsewhere.

FUEL ECONOMY IN STEAM GENERATION.

THE PRINCIPLES OF THE ECONOMICAL USE OF COAL FOR THE PRODUCTION OF POWER BY THE GENERATION OF STEAM.

New England Water-Works Association.

AMONG the valuable papers in the recent issue of the *Journal of the New England Water-Works Association* is one by Professor Ira N. Hollis upon economy in the use of coal for the production of power.

Professor Hollis goes right to the root of the question at the start, when he says:

"The fundamental motive at the base of all human invention is in the direction of saving labor, and thus of increasing the material comforts and leisure of the race. Broadly stated, this means that coal or water must do the work which men formerly did by hand; hence, for every ton of coal which we have been able to save by the increased efficiency of furnaces and machines, many tons have been added to the yearly expenditure by the enormously greater demand for power. We are already beginning to talk about how long the available supply of coal will last, and the late strike in the anthracite regions has quickened interest in the subject, as it has given us a hint of what a coal famine would mean to a nation accustomed to depend upon it for work and heat. Yet we have hardly attacked the problem of economy in the use of coal."

Examining the thermal value of coal and the possible maximum thermal and mechanical efficiency of boilers and engines, Professor Hollis shows that the maximum attainable efficiency, under ideal conditions is 26.5 per cent. Of this we have attained already about 12 per cent., and we are still striving for the remaining 14.5 per cent.

"Engineers may well strive out on a new path. We are struggling with the steam turbine and with other inventions to save a few pounds of coal, while we are wasting tons.

"One of the axioms of modern engineering is that the conditions most favorable to economy are the regular and constant demand for power. Where an engine is to be run at its designed maximum power for twenty-four hours a day, the entire plant can be made to realize a much higher efficiency than would be the case with a fluctuating demand for work. Where this fluctuating demand prevails the plant must be designed for the greatest output and yet used for long periods at much lower rates. This is like employing a man to do the work of a child because at times there are weights to be lifted that require a man's strength. Furthermore, paradoxical as it may seem, there are many cases in which economy would be obtained at too great a cost: a good example of this being found in steam engines for small powers. It would not pay to build a one-horse power with a steam jacket and condenser and air-pump. The first cost would be too great and the skill to render the design effective would be far beyond the ordinary rate of wages. The line of improvement in the use of small powers is clearly pointed out: a central station which can be kept working at a constant rate and some efficient method of distribution to motors of such simplicity that cheap labor can be employed to run them. This may be called the problem of the twentieth century, inasmuch as there are many demands for small power to a comparatively few for power in large quantities."

Examining the present causes for waste in the use of fuel, and their immediate remedies, Professor Hollis says, very truly, that coal is rarely burned in an intelligent manner. Skilful hand firing is more advantageous than mechanical stoking, but skilled hand firing is the exception. While this may be true, and it is possible that much may be done by the proper education of firemen, it must be remembered that firing boilers is by no means a desirable form of work, and men who can learn to do such work well are not likely to remain firemen unless much better paid than is now the rule; while if much higher wages are paid to secure greater skill all the benefit of the firing will be offset by the increased wages.

The dirty condition of most boilers is a fruitful source of loss, and this again is largely due to neglect. Cleaning boilers is even more disagreeable work than firing them, and it will never be effectively done unless under strict supervision and compulsion. The inside may be kept clean by putting only pure water into them, and the best way to keep the outside clean is also the best way to get efficient firing, i. e., to use clean gaseous fuel.

So far as losses in the engine are concerned, Professor Hollis examines principally those due to cylinder condensation. The advantages due to jacketing he shows to depend upon circumstances, and its use should be made with judgment. It is quite possible to over-jacket an engine, heat being lost by using too much jacket steam. The success of a jacket depends largely upon discharging all the condensed water, so that the latent heat stored in the steam may become useful, and hence a good circulation in the jacket is essential. The benefits of superheating are shown to be great, and a moderate degree of superheat is recommended.

Losses from leakage are much greater than are usally suspected, and many calculations upon the action of steam in the cylinder are unreliable because the condition of the valves was not definitely determined and made a part of the record. Another cause of loss by leakage, and one which is not investigated as frequently as it should be, is that of inward leakage of cold air into the flues and boiler brickwork. It is of little use to proportion all parts with care to obtain certain pre-determined results and then have leaks of unknown magnitude, both inward and outward, producing conditions altogether different from those intended and desired.

When all has been said and done, however, the use of coal for the production of power by means of steam is far from being as economical as it should be, and the paper of Professor Hollis has mainly shown how little we may expect from following existing lines of construction and design. Apparently it is time to strike out on altogether new paths, and it seems as if some guide to those paths might even now be discerned.

It is admitted that the internal-combustion motor is far more economical than the steam engine can ever hope to be. This follows because of its much greater temperature range, and its fewer opportunities for losses. To this fact is added that of the practicability of making lean gas for such engines from fuel which it would be hopeless to attempt to use to advantage in the generation of steam. Apart from this, however, there appears another element in the economical use of fuel, one which has until recently been altogether disregarded. One of the most extensive uses of fuel is found in metallurgical operations, the coke ovens and blast furnaces of the country consuming thousands of tons of fuel in the production of iron, at a rapidly increasing rate. In nearly all such operations the gases discharged after the smelting has been effected are available for the production of power in internal-combustion engines, the coal thus performing double duty, with a corresponding degree of economy.

The principal element in the realization of the utilization of the power available in the waste gases of our coke ovens and blast furnaces lies in the necessity of so arranging the distribution and use of power that it may be available. This is rather a problem in economics than in engineering, since it involves the perfecting of relations between manufacturing and metallurgical industries which at present do not exist. Nevertheless, in these days of combination and consolidation, such arrangements are by no means impossible, and it is altogether possible that the next great move in the utilization of the energy contained in coal will be the development of the iron smelting districts as power-generating centres, from which energy may be distributed at prices otherwise impossible.

INDICATING HIGH-SPEED ENGINES.

PRECAUTIONS TO BE OBSERVED FOR OBTAINING ACCURATE DIAGRAMS FROM ENGINES WITH HIGH ROTATIVE SPEEDS.

Institution of Civil Engineers.

IN recent issues we have reviewed in these columns the methods which have been applied in practice to calibrate the springs of steam engine indicators and to make the necessary corrections for the instrumental errors thus determined. The errors due to the influence of heat upon the springs appear in slow as well as high-speed engine work, but with the latter there are other difficulties which in the early experiences with slow moving engines were almost inappreciable.

In a paper recently presented before a meeting of the students of the Institution of Civil Engineers by Mr. A. Marshall Arter, the elements of error in high-speed indicating were discussed in an interesting and suggestive manner, and some abstract of his paper will here be given.

It is interesting to note that nearly all the improvements which have been made over the original indicator of Watt have been due to efforts to adapt the instrument for use at higher speeds than were at first considered. The substitution of the drum for the flat slide was the principal improvement in the MacNaught instrument, which served all practical purposes until the advent of the Porter-Allen high-speed engine caused Richards to turn his attention to the subject, and to design the form which, with minor modifications has been in use ever since. Even the improvements which subsequent designers have introduced have been mainly with the object of adapting the instrument to still higher speeds, including lighter moving parts, improved drum movements, etc., but with all the attention which has been given to the subject it is yet possible for material errors to creep into the diagram;

and unless the exact conditions under which it was taken are known, erroneous conclusions may be drawn.

In all cases it is important that the friction of the indicator piston be kept as small as possible, but Mr. Arter calls attention to its especial necessity in high-speed work. It is much better to have a piston slightly leaky than to have it too tight, and when the spring is removed from the instrument the piston should always fall freely in the cylinder by its own weight. The choice of spring for high-speed work is also a matter for consideration. Springs are ordinarily rated by their scale and by the maximum pressure they should receive, but the selection should also be governed by the point of cut-off, as influencing the suddenness of the drop in pressure, and by the weight of the moving parts of the indicator and their speed as affected by the number of revolutions of the engine. It is well understood that at high speeds small diagrams are more likely to be correct than larger ones, and some of the manufacturers make special small instruments for high speeds. With the ordinary indicators, however, good results may be obtained by using stiffer springs and taking short diagrams, and Mr. Arter gives formulas for determining the proper height and scale of diagrams for various speeds and pressures for the Darke indicator, used by him in indicating the engines of torpedo-boat destroyers at speeds as high as 400 revolutions per minute.

A most fertile source of error in high-speed diagrams is that of the stretching and sagging of long cords in the drum connection. The tension upon the cord which transmits the reduced motion of the piston to the indicator drum varies with the tension of the drum spring and with the inertia of the drum and of the cord itself. If a constant tension can be maintained upon the cord its length should not vary throughout a stroke. By plotting the combined action of spring tension and drum inertia it can be shown that there is only one particular speed of engine at which the cord tension is constant. Increasing the spring tension does not remove this difficulty, since what is required is a means of varying the rate of increase of tension of the spring, a matter which has, as yet, not been satisfactorily accomplished. Several drum springs may be fitted, for use with various speeds, and Mr. Arter also makes the suggestion that the inertia of the drum may be made variable by supplying drum tops of different weights, the heavier ones to be used for slower speeds and replaced by lighter ones for higher speeds, thus maintaining the inertia of the drum comparatively constant.

Mr. Arter gives a number of diagrams taken at high speeds to show the various errors which may appear, and points out how in many instances the defects have been removed by tracing the cause.

The effect of the inertia of the cord itself is clearly shown by attaching a small weight to the cord and observing the effect upon the diagram, the result being to exaggerate the action due the weight of the cord. The result of the inertia upon the tension of the cord is such as to affect the proportional length of the diagram for the fast and slow periods of its motion, thus causing the cut-off and compression curves to be distorted. Indeed Mr. Arter shows a case in which the inertia effects were sufficient to cause the drum to be stationary when it should be in motion, or even to have its movement momentarily reversed, with corresponding distortions of the diagrams.

An examination of the diagrams illustrating Mr. Arter's paper reminds one of the indicator cards which were exhibited in the early papers about the Richards indicator, showing the defects in diagrams taken with the old McNaught indicator when used at speeds beyond its capabilities. It appears almost as if similar conditions had again been reached in the use of the indicator, and that corresponding improvements were again necessary to meet the high speeds, and pressures, and early cut-offs now employed.

So far as defects from the stretching and sagging of the cord are concerned, they may be minimised by reducing the length of cord employed, replacing the greater portion of the length of connection between the cross head and the indicator drum by a positive member, or one with freedom from stretch. In some modern engines the indicator motion is provided with a steel rod or bar for all but a very short portion of the connection, this being guided and supported so as to make a practically positive connection, but a few inches of string being necessary at the end. Another arrangement has the connection made of tightly stretched piano wire, pulling against a strong spring, a loop near the end of the wire permitting the attachment of the short string leading to the indicator drum. By such means the length of cord capable of stretch and sag may be greatly reduced, and the accuracy of the motion improved.

The great importance of adopting every possible means to insure accurate and reliable indicator diagrams is becoming more generally appreciated as it is understood that the size, speed, and power of engines have increased enormously without any corresponding increase in the scale of the diagram upon which the power is measured. The long end of the lever has been continually growing longer while the measurements still have to be made at the short end. It is not too much to say that no great degree of confidence can be placed in an indicator diagram from a modern high-speed, large-power engine until all the conditions under which it was taken are known, and unless the calibrated errors of the instrument with which it was taken are appended.

INVENTIONS BY EMPLOYEES.

CONTRACT AGREEMENTS BETWEEN EMPLOYERS AND EMPLOYEES AS TO THE OWNERSHIP OF MECHANICAL INVENTIONS.

American Machinist.

IT has long been recognized that the question of the rights of employers to inventions made by their employees is a delicate one, and various opinions have been held concerning it. Formerly the employer insisted that all inventions made by an employee belonged to him absolutely, and when it was found that the courts did not sustain this position it was made the subject of a contract to be entered upon as a condition of employment. At the present time, however, a more reasonable view obtains, and in a recent issue of the *American Machinist* is given a form of agreement between the employees of a manufacturing establishment and the firm, which that journal comments upon editorially in rather favorable terms.

The whole subject is an interesting one, especially as it leads to a consideration of the modern status of the inventor in several directions, as well as to the conditions which best stimulate the development of inventive genius. The contract given in the *American Machinist* after reciting the fact that the employee, by reason of his employment and the nature of the work he is to do, will come into possession of certain knowledge concerning the business which it is not desirable that competitors should possess, binds him not to divulge such information to anyone.

The rest of the agreement relates to inventions and to title in patents thereon, and provides that any invention made by the employee pertaining to the company's product or work shall be made known to the company or its representative, and if thought worth while by the company a patent it to be taken out at the expense of the company, which is to have exclusive right to its use so long as the inventor remains in its employ. Should he leave, however, the right ceases to be exclusive. It provides further that when the company desires to obtain full control of the invention it can do so by payment of a sum to be agreed upon, and this may be done either during the continuance of the employment or after, the company having first right to purchase within a specified time, after the expiration of which the employee is at liberty to dispose of his invention to anyone else.

The propriety of signing such an agreement, as the *American Machinist* remarks, is a matter upon which there may be some difference of opinion, but it is a matter of common knowledge that nearly all large manufacturing companies have some sort of an agreement which is made a condition of employment, and many of these contracts are by no means so liberal to the employee as the one abstracted above, and printed in full in the journal referred to. It is not the form of agreement, so much as it is the effect upon the development of the inventive faculty, of which we desire to speak.

The old idea of an inventor was that of a man who after long years of privation and labor, succeeded in perfecting some device which he then patented and by which he soon realized a fortune. Such things have happened, and because of their remarkable nature they have naturally attracted much more attention than the innumerable instances in which men have wasted their lives in endeavoring to accomplish something which a limited knowledge of physics, chemistry, or mechanics would have shown them was impossible.

Such inventors are not unknown at the present time, but by far the greatest number of valuable inventions are developed by trained investigators, employed for the purpose by corporations who make a department of research a part of their working equipment.

That this is a system altogether desirable, or free from abuses is open to question. Thus Mr. William Stanley, in a letter originally published in the Springfield Republican, and widely reprinted, says:

"I believe the present methods adopted by the industrial trusts in dealing with the inventor, his work, his aims and rewards will, if uncontrolled in the future, annul his usefulness discourage his endeavors, disgust him with surrounding conditions, and finally remove him from the land.

"The industrial trusts now regularly employ, on salaries or by retainers, bureaus known as boards of patent control. To these boards is intrusted the problem of controlling the arts, by means of patents. They are expected to purchase such patents as they deem expedient, to manufacture any others they think necessary, to gather up fresh lines of patents wherewith to assail competitors, to bring suits against infringers, real or imaginary, and generally to operate an offensive patent campaign against competition."

At the same time it must be recognized that the modern method has its advantages, and while modifications in the legal side of patent protection may be necessary, any prevention of organized scientific research for commercial purposes could not fail to be an injury to the progress of practical science. It has been maintained that such organized research will check invention, but it is a matter of certain knowledge that many of the agreements which are required by companies of their skilled employees act to deter the latter from attempting to make any improvements in the methods or machinery of their work. No man will take the trouble to invent a new device, the rights to which he has already turned over to another. If, as is sometimes the case, an able man discovers something new and valuable, something which he thinks is really worth while, he will keep it very quiet indeed, and give up his employment without intimating that he has any ideas whatever upon the subject, and delay the application for patent protection until he is free from the entangling agreement, taking care to use only dates subsequent to his cancellation of the contract. In either case the only effect of systematic attempts of either party to overreach the other must result in a stifling of invention and a retardation of technical progress.

The essential stimulus to invention lies in the large rewards which it has hitherto held out to the successful inventor. If it is to become a daily trade, receiving only the daily wage, with possibly a small bonus, held out as a bait to encourage special effort, the great incentive will be removed, and with it much of the activity which now impels the ingenious man to put his ideas into practical shape. Since originality is not a quality which can be created at will, however much it may be developed by study and opportunity, it is evident that all methods for securing to the employer his share in the products of the inventive genius of his employees must be devised with care, or they may succeed only in suppressing all effort, a clear case of killing the goose which has laid many golden eggs.

The probable result of the changed conditions of technical development will be the advancement of the true inventor, as distinguished from the old time empiricist, and the rewards of invention will become similar in nature to those of other professional lines of work. The solution of problems which manufacturing establishments stand ready to develope according to modern commercial methods may well become an established profession, commanding large returns, and offering inducements fully equal to the practice of the law, of medicine, or even of science of destruction.

THE ENGINEERING INDEX

"THE ENGINEERING INDEX IS THE KEYSTONE OF APPLIED SCIENCE"

The following pages from a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals if the world,—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger division of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches

Arch Bridge Construction on the C. M. & St. P. Ry. Illustrates and describes some improvements on the La Crosse division, in Wisconsin, in the erection of stone and concrete bridges. 900 w. Ry & Engng Rev—March 14, 1903. No. 54116.

Parabolic Lines of Pressure and the Computation of Two-Hinged Arches (Ueber Parabelförmige Einflusslinien und die Berechnung des Zweigelenkbogens). H. Müller-Breslau. A discussion of the determination of the true line of pressure for two-hinged arches under various loads. 2500 w. Zentralblatt der Bauverwaltung—March 4, 1903. No. 54274 B.

Stone Arch Bridge on the Chicago, Milwaukee & St. Paul Ry. at Watertown, Wis. Illustrated description of the construction of a four-span, double-track, stone arch bridge over the Rock river without interruption of traffic. 600 w. Eng News—March 26, 1903. No. 54359.

The Construction of the Centers for the Luxemburg Arch Bridge. Illustrated detailed description of centers used for the main arch and for the shorter side arches. 1400 w. Eng News—March 5, 1903. No. 54034.

We supply copies of these articles. See page 317.

The Nine-Mile Run Steel Arch Bridge at Pittsburg, Pa. Willis Whited. Illustrated description, with explanation of the considerations governing the design, and an account of the erection of the superstructure. 3400 w. Eng News—Feb. 26, 1903. No. 53849.

Continuous Girders.

Beams with Elastic Secured Ends (Der Träger mit Elastisch Gebundenen Enden). A. Franke. A study of the resistance of continuous girders with the ends secured, subject to elastic stresses. Two articles, 4500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Feb. 7, 14, 1903. No. 54270 each D.

The Computation of Continuous Girders over Three Openings (Zur Berechnung von Kontiuierlichen Trägern ueber Drei Oeffnungen). Joh. Thieme. A mathematical treatment, deriving equations for the deflections according to the elastic theory. 1800 w. Deutsche Bauzeitung—Feb. 23, 1903. No. 54272 B.

East River, New York.

Completion of the Floor of the New East River Bridge. Illustrates and describes the work already completed. 700 w. Sci. Am—March 14, 1903. No. 54086.

The Blackwell's Island Bridge. Brief illustrated description of bridge No. 4, crossing from 59th & 60th streets, Borough of Manhattan, to the Borough of Queens. It will be the heaviest and most capacious long span bridge ever constructed, and, with one exception, the longest truss span ever built. 1500 w. Eng Rec—Feb. 28, 1903. No. 53899.

Elliptical Bridge.

A Curious Elliptical Bridge. Illustrates and describes a novel construction in the North of Ireland, erected to enable tourists to safely view the wild, picturesque scenery, and gain access to interesting caves. 800 w. Sci Am—March 21, 1903. No. 54164.

Erection.

Erection of the Northwest Miramichi Bridge, Newcastle, N. B. H. D. Bush. Read before the Canadian Soc. of Civ. Engrs. Describes this new bridge of the Intercolonial Ry., the removal of the old spans, and method of erecting the new. 2200 w. Can Engr—March, 1903. No. 53981.

Fort Dodge, Iowa.

The Chicago Great Western and the Fort Dodge Bridge. An illustrated description of a viaduct having a total length of 2,582 ft., with many features of interest. 4000 w. Ry Age—March 20, 1903. No. 54349.

Removal.

A Novel Plan for Removing a Bridge. An illustrated account of the bridge on the D., L. & W. R. R., crossing the Passaic river at Newark, N. J., where the action of the tides complicated the problem. 1400 w. Ry Age—March 20, 1903. No. 54345.

Suspension.

A Comparison Between Eye-Bar Chains and Wire Cables for Suspension Bridges. Wilhelm Hildenbrand. Showing that economy is decidedly on the side of wire cables, and criticising the alteration made in the "Manhattan" bridge. 4800 w. Eng News—March 12, 1903. No. 54090.

Report of Special Commission of Engineers on the Plans for the Manhattan Bridge, New York City. Supports Mr. Gustav Lindenthal's claims that the substitution of eye-bar chains will give increased rapidity of erection and no greater first cost. 1800 w. Eng News—March 12, 1903. No. 54094.

Trenton, N. J.

The Delaware River Bridge of the Pennsylvania Railroad at Trenton, N. J. Illustrated description of the construction of a new four-track stone arch bridge at this point, and a change in location of tracks. 2000 w. Ry Age—March 20, 1903. No. 54350.

Trestle Work.

A Railway Trestle with Bents of Reinforced Concrete. William A. Allen. Brief illustrated description of work at Perth Amboy, N. J. 800 w. Eng News—March 12, 1903. No. 54095.

Viaduct.

Results of the Tests of the Viaur Viaduct (Résultats des Epreuves du Viaduct du Viaur). Describing the manner in which the viaduct was loaded with locomotives and cars. The deflections were much less than had been computed. 1800 w. Rev Gen des Chem de Fer—Feb., 1903. No. 54258 H.

Viaduct over the Viaur. Illustrates and describes a remarkable structure which carries the railway from Carmaux to Rodez, in the south of France. It is a system of balanced arches on a scale of great magnitude. Describes methods of erection, materials, etc. 1200 w. Engr, Lond—Feb. 27, 1903. No. 54017 A.

Wheel Loads.

A Conventional System of Treating Wheel Loads. M. F. Brown. Gives results of investigations made recently by the writer of the "Two Floor-beam Maximum" method, and also other methods. 1500 w. Eng News—March 26, 1903. No. 54363.

CANALS, RIVERS AND HARBORS.

Breakwaters.

The Accident to the Buffalo Breakwater.

An illustrated account of the serious settlement that occurred Dec. 10, 1902, describing the proposed method of repairing. 600 w. Eng News—March 19, 1903. No. 54307.

The Development of Buffalo Harbor. Emile Low. From a paper before the R. R. Branch of the Y. M. C. A. Briefly reviews previous work and gives an illustrated account of the breakwater system in process of construction which will make this one of the finest harbors. 2500 w. R R Gaz—March 13, 1903. No. 54130.

Canada.

Tide Levels and Datum Planes in Eastern Canada. W. Bell Dawson. Information gathered in connection with the tidal survey regarding tidal levels and facts of importance in harbor construction, etc. 15,500 w. Can Soc of Civ Engrs, Adv Proof—March, 1903. No. 54143 D.

Canal Traction.

See Electrical Engineering, Power Applications.

Cumberland Sound, Fla.

The Improvement of the Entrance to Cumberland Sound, Georgia and Florida. James H. Bacon. Gives description of the work, with maps, and editorial on the striking contrast of the cost of the work, with that done under the Carter conspiracy. 4000 w. Eng News—March 12, 1903. No. 54093.

Dams.

A Small Rock-Fill Dam. H. deB. Parsons. Illustrated description of a dam designed to impound a gravity water supply on an estate in New Jersey and of its construction. 1500 w. Pro Am Soc of Civ Engrs—March, 1903. No. 54379 E.

Straight-Faced Dams (Barrages à Parements Rectilignes). G. Cadart. A discussion of the distribution of pressure in masonry dams, and the construction of rectilinear sections of stability and economy. 9000 w. Ann des Ponts et Chaussées—3 Trimestre, 1902. No. 54250 E+F.

Danube.

The Work on the Lower Danube between Tultscha and the Sulina Mouth (Die Arbeiten an der Unteren Donau Zwischen Tultscha und der Sulinamündung). Data concerning the dredging and other improvement works on the lower Danube in Roumania. 2500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst —Feb. 28, 1903. No. 54271 D.

Docks.

See Marine and Naval Engineering.

Dredging.

Modern Machinery for Excavating and Dredging. A. W. Robinson. The second article describes, with many illustrations, the heavier types of dredges, adapted to tidal harbors and deep waterways. 3500 w. Engineering Magazine—April, 1903. No. 54283 B.

Suction Dredging in the Estuary of the Seine (Les Dragages par Succion dans l'Estuaire de la Seine). L. Sekutowicz. An account of the deepening of the channel at the entrance to the Seine, with illustrations of the suction dredge used. 2000 w. 1 plate. Génie Civil—Feb. 14, 1903. No. 54200 D.

Twenty-In. Tydraulic Dredge King Edward. A. W. Robinson. Read before the Can. Soc. of Civ. Engrs. Illustration, with description of this dredge which is to be used for work on the Pacific coast. 2800 w. Can Engr—March, 1903. No. 53983.

Flow.

A Problem in Hydraulics (Note sur un Probleme d'Hydrauliques). Ed. Collignon. A graphical and analytical study of the action of floods in rivers and other streams 3000 w. Revue de Mécanique—Feb. 28, 1903. No. 54256 E+F.

Study of a New Formula for the Velocity of Water (Studie über eine Neue Formel Zur Ermittlung der Geschwindigkeit des Wassers). R. Siedek. An examination of a number of data of water flow in small streams and artificial channels, and the derivation of a formula including the results. Two articles. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 13, 20, 1903. No. 54220 each B.

The Flow of Streams. R. S. Lea. A collection of rainfall and stream flow records, given in tables, including streams differing in extent of drainage area, geological conditions, rainfall and climate. Much related information is also given. 7 plates. 10,000 w. Can Soc of Civ Engrs; Adv Proof—March, 1903. No. 54141 D.

Holland.

The Eems Canal and Its Accompanying Canals and Streams (Hel Eems Kanaal en de darop Afwaterende Kanalen en Riviertjes.) D. H. S. Blaupot ten Cate. A general account of the canal system about Groningen, Holland, with map. 5000 w. 1 plate. De Ingenieur—Feb. 28, 1903. No. 54268 D.

Isthmian Canal.

The Panama Canal. Discussion of paper by George S. Morison. 7800 w. Pro Am Soc of Civ Engrs—March, 1903. No. 54381 E.

Lock.

The New Lock at Port-a-l'Anglais on the Upper Seine (Nouvelle Ecluse à Port-a-l'Anglais sur la Haute Seine). M. Alby. With full details of the masonry construction, the operation of the gates, and the sluices. 5000 w. 3 plates. Ann des Ponts et Chaussées—3 Trimestre, 1902. No. 54249 E+F.

Mississippi.

The Yazoo River Diversion. Canal at Vickburg, Miss. Gives the history of the project, methods of work, and illustrations. 2200 w. Eng News—March 12, 1903. No. 54089.

New York Canals.

A Deep Waterway from the Lakes to the Atlantic. A description of this proposed ship canal, with editorial making a comparison with the 1000-ton barge-canal project before the New York legislature, and favoring the Federal deep waterway. Ill. 5300 w. Eng News—Feb. 26, 1903. No. 53852.

The Canal Discussion in New York. Editorial discussion of the arguments to be brought before the New York legislature. 2000 w. Eng News—March 19, 1903. No. 54309.

Nile.

The Construction of the Asyut Dam; Nile Irrigation Works. Interesting views of this second great dam across the Nile, with official description from notes by Sir Benjamin Baker. Also editorial, drawing comparison between the rapidity of engineering construction of these great works, and the slow construction of the great municipal works of New York City. 4000 w. Sci Am—Feb. 28, 1903. No. 53843.

The New Nile Reservoir. Frederic Courtland Penfield. Reviews the history of this project, and discusses the importance of the work, some of its features and the benefits expected. 4500 w. N Am Rev—March, 1903. No. 53929 D.

The Nile Dams and Reservoir. Sir Benjamin Baker. Address before the Royal Inst. of Great Britain. An account of this great engineering work—the construction of the Nile reservoir and dam at Assouan, the barrage at Asyat, and the various supplementary works. Ill. 5000 w. Pop Sci M—April, 1903. No. 54328 C.

Tides.

Why Tidal Energy or the Force or Power of the Rising and Falling Tides Has Not Been, and Cannot Be, Economically Subservient to the Requirements of Man for Industrial Purposes. C. P. Baillairge. An examination of this subject, discussing the difficulties, and giving conclusions. 4500 w. Can Soc of Civ Engrs, Adv Proof—March, 1903. No. 54140 D.

Trent Canal.

The Trent Valley Waterway. R. B. Rogers. A brief description of a projected waterway to connect Georgian Bay on Lake Huron, with Lake Ontario, at Trenton, a distance of about 200 miles. 2000 w. Marine Rev—March 5, 1903. No. 54020.

CONSTRUCTION.

Beams.

Deep-Section Rolled Beams. An illustrated description of rolled steel I girders for structural work, made at the Differdange Steel Works in a newly invented mill which permits the production of I beams as much as 29½ in. deep by 12 in. wide. 900 w. Engr, Lond—Feb. 27, 1903. No. 54014 A.

Deflections of Beams with Variable Moments of Inertia. C. W. Hudson. Gives a general method for determining the deflections of solid-webbed girders under flexure, illustrating its application to the forms of girders most frequently met in practical bridge construction. 3800 w. Pro Am Soc of Civ Engrs—March, 1903. No. 54380 E.

Building Construction.

Foundations and Steel Work in the Government Printing Office in Washington, D C.. Illustrated description with data relating to the construction. 3500 w. Eng Rec—March 7, 1903. No. 54048.

Earthwork.

An Exact Graphical Method for Computing Embankments and Cuttings (Genaue Zeicherixhe Ermittelung des Flächenprofiles und des Grunderwerbes). R. Schönhöfer. Developing curves from which quantities may be taken out by direct scaling. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 27, 1903. No. 54221 B.

Fireproof.

Destruction of an English Mill. Account of a fire which destroyed the Vernon cotton mill in Stockport, England, showing the inability of unprotected iron to withstand fire. Ill. 1200 w. Ins Engng —Feb., 1903. No. 53934 C.

Foundations.

The Restoration of the Foundations of the Philae Temples. An illustrated account of the underpinning made necessary to preserve the buildings against the head of water when the new reservoir is full. 1800 w. Sci Am—March 14, 1903. No. 54087.

Masonry.

Concrete Masonry. Extracts from the report of the Committee of the Am. Ry. Engng & Maintenance of Way Assn. Presents specifications for cement, recommending the use of a wet concrete. 4000 w. R R Gaz—March 27, 1903. No. 54358.

Reinforced Concrete.

Steel Concrete Construction. A. L.

Johnson. Setting forth the great advantages of reinforced concrete construction, and giving convenient working formulas for beams. 1300 w. R R Gaz—March 13, 1903. No. 54128.

Roads.

Macadam Roads and Road Specifications. Ernest McCullough. A brief review of methods used in the construction of macadamized streets, with a record of some of the difficulties encountered. 3000 w. Eng News—Feb. 26, 1903. No. 53850.

Roofs.

Economy in Roofs. A reply in part to a paper by Mr. Ewing Matheson, published on Jan. 9th, and especially discussing recent examples and their cost. 3000 w. Engr, Lond—March 13, 1903. No. 54196 A.

Tunnels.

Air-Testing in Tunnel Construction. Joseph W. Ellms. Reports concerning the use of the Shaw gas-tester, at Cincinnati. 2500 w. Eng Rec—March 7, 1903. No. 54049.

Improved Methods for Difficult Subaqueous Tunneling. Brief illustrated descriptions of some of the methods that have been proposed for the construction of important tunnels in connection with the transit systems of New York. Also editorial. Ill. 4800 w. Eng Rec—March 14, 1903. Serial, 1st part. No. 54124.

Ventilation of Subways and Tunnels. Editorial on the need of studying this subject, referring to recent articles bearing upon it, and reporting the conditions of the air. 1800 w. Eng Rec—March 7, 1903. No. 54047.

Underpinning.

Direct and Indirect Supports for Underpinning a High Wall. Brief illustrated description of method used at 56 Cedar street, New York, for underpinning a heavy wall and piers with needle beams and cantilevers. 1200 w. Eng Rec—March 21, 1903. No. 54326.

MATERIALS.

Asphalt.

Asphalt Refining. Prof. W. R. Crane. Illustrated article describing methods employed in the Tar Springs Asphalt Co.'s refinery, near Comanche, Ind. T. 4700 w. Mines & Min—March, 1903. No. 53974 C.

Brick.

An Investigation of the Properties of Brick, Under Different Physical Conditions. Sherman M. Turrill. An illustrated account of tests conducted at Cornell University, giving the methods of procedure, the results of the tests, and an outline of the conclusions. 8000 w. Pro Am Soc of Civ Engrs—March, 1903. No. 54378 E.

Cement.

The Passing of Natural Rock Cement. F. H. Doremus. A discussion of the decadence of this industry and the causes. 2000 w. Am Archt—March 28, 1903. No. 54398.

Concrete.

Note on the Coefficient of Elasticity of Concrete and Mortar Beams During Flexure. Myron S. Falk. Gives valuable results for concrete and mortar beams tested to the point of failure. 600 w. Pro Am Soc of Civ Engrs—Feb., 1903. No. 53-950 E.

The Constituent Parts of Concrete. Abstract of a paper by Charles M. Crawford, read before the Connecticut Soc. of Civ. Engrs. Considers methods of testing followed by various engineers, the mixtures used, etc. 2300 w. Eng Rec—March 7, 1903. No. 54052.

Mortar.

The Decomposition of Mortar (Décomposition des Mortiers). J. Bied. An examination of the decomposing action of water charged with sulphate of lime upon mortar, citing important examples. 5000 w. Ann des Ponts et Chaussées—3 Trimestre, 1902. No. 54252 E+F.

Preservation.

The Preservation of Materials of Construction. An interesting informal discussion of this subject. Ill. 11300 w. Pro Am Soc of Civ Engrs—March, 1903. No. 54382 E.

Steel Protection.

The Preservation of Steel. An illustrated description of the condition of the steel frame work found in the demolition of the Pabst Building in New York City. The conclusion reached is that concrete is a very efficient protection. 900 w. Ins Engng—Feb., 1903. No. 53933 C.

Stone.

The Stone Resources of South Dakota. An illustrated account of the quarrying industry of this state and facts in regard to the stone resources and building material. 1500 w. Stone—March, 1903. No .54-145 C.

Timber.

Fungi, Merulius Lacrymans, and other Growths Injurious to Timber (Ueber Hausschwarum, Merulius Lacrymans, und andere Holzzerstorende Pilze). Dr. H. Zikes. A study of the diseases of timber as affecting its use for structural purposes, discussing various preservatives. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—March 6, 1903. No. 54222 B.

Tests of the Relation Between Cross Bending and Direct Compressive Strength in Timber. Clarence A. Martin. An account of tests made at Cornell University, with tabulated results. 1500 w. R R Gaz—March 13, 1903. No. 54129.

The West Pascagoula Creosoting Works. Illustrated description of this important plant in Mississippi, for treating piles, wharf timbers, bridge timbers, cross ties, cutout and foundation timbers of all sizes, ship timbers, etc. 1800 w. Ry & Engng Rev—March 14, 1903. No. 54118.

MEASUREMENT.

Level Rod.

A New "Automatic" Level Rod. Illustrates and describes a recent patent in which the rod reading itself is the cut, fill or elevation. 1000 w. Eng News—March 12, 1903. No. 54092.

Metric System.

See Mechanical Engineering, Measurement.

MUNICIPAL.

Fire Protection.

Existing Laws, By-Laws, and Regulations Relating to Protection from Fire, with Criticisms and Suggestions (Fothergill Prize Essay). T. Brice Phillips. An outline of British laws as to fire protection, explaining the principle underlying them, and considering the subject generally. Also papers by George H. Paul, and by W. Craig Henderson, on this subject. with discussion. 2500 w. Jour Soc of Arts—March 13, 1903. No. 54180 A.

Garbage.

Some Features of the New Garbage Reduction Works at Buffalo, N. Y. Slightly condensed paper by C. A. Blessing describing some parts of these reduction works. 700 w. Eng News—Feb. 26, 1903. No. 53855.

Pavements.

Coal Tar Pavements. Allan Wade Dow. An illustrated article claiming remarkably low cost for repairs, and reporting in regard to pavements over thirty years old, and their methods of construction. 3000 w. Munic Jour & Engr—March, 1903. No. 53966 C.

How to Lay Brick Pavements. Ira O. Baker. An illustrated article considering details of construction, and the merits of this kind of pavement. 2700 w. Munic Jour & Engr—March, 1903. No. 53964 C.

Medina Block Stone Pavements. E. A. Fisher. Gives good points of this pavement and model methods of construction. Ill. 4000 w. Munic Jour & Engr—March, 1903. No. 53961 C.

Pavements for Small Cities. F. F. Rogers. Considers streets and roads where expensive pavements are not warranted, recommending well-constructed macadam. Ill. 1800 w. Munic Jour & Engr—March, 1903. No. 53965 C.

The Bitulithic Pavement. Walter B. Warren. A statement of its advantages, claiming that it possesses the good qualities of macadam without the defects. Ill. 3000 w. Munic Jour & Engr—March, 1903. No. 53962 C.

Wood Paving in England and America. F. A. Kummer. Gives information of the classes of wood used, and the methods, serviceability, etc. Ill. 2000 w. Munic Jour & Engr—March, 1903. No. 53963 C.

Refuse.

The Sanitary Disposal of Municipal Refuse. Informal discussion by Messrs. Falk, Baker, Baldwin and Parsons. 4000 w. Pro Am Soc of Civ Engrs—Feb., 1903. No 53951 E.

The Sanitary Disposal of Municipal Refuse. Continued informal discussion of this subject. Ill. 10000 w. Pro Am Soc of Civ Engrs—March, 1903. No. 54383 E.

Sewers.

Crossing Under the Sudbury Aqueduct with a Sewer Pipe. Charles W. Sherman. Describes two plans submitted, and gives detailed description of the work of construction of the accepted plan. Ill. 1700 w. Eng Rec—Feb. 28, 1903. No. 53901.

Detroit Sewer System. W. C. King. Brief description of the gravity system in use, and the construction. 1400 w. Jour Assn of Engng Socs—Jan., 1903. No. 54160 C.

Shone Ejector Plant at Worcester, Mass. Harrison P. Eddy. Describes the schemes for disposal of sewage in this district, especially the plant for the Worcester Highlands. 1200 w. Eng Rec—Feb. 28, 1903. No. 53902.

Statistics.

Analysis of the Seventh Annual Report of the Public Lighting Commission, Detroit, Mich. A critical analysis with editorial comments. 7500 w. Elec Wld & Engr—Feb. 28, 1903. No. 53956.

Storm Water.

The Measurement of Rainfall and Run Off (Ueber Regenhöhen und Abflussmengen). Prof. Büsing. A discussion of the probable rainfall in cities and the volume of storm water to be provided for by the sewage systems. 5000 w. Gesundheits-Ingenieur—Feb. 28, 1903. No. 54263 B.

WATER SUPPLY.

Filtration.

Automatic Modules for Regulating the Speed of Filtration. Charles Anthony, Jr. Considers the requirements which an apparatus of this kind should fulfil, and describes various forms of controller designed for this purpose. Ill. 1400 w. Pro

Am Soc of Civ Engrs—Feb., 1903. No. 53949 E.

Slow Sand Filtration Plant for Washington, D. C. J. S. Schultz. An illustrated description of the proposed plant, with brief account of the investigations that led to its recommendation. 3500 w. Eng Rec —March 14, 1903. No. 54123.

The Filtration Works of the East Jersey Water Company, at Little Falls, New Jersey. George W. Fuller. History of the undertaking, general description of the pumping station, and detailed description of the filtration works and their operation, with illustrations. 6500 w. Pro Am Soc of Civ Engrs—Feb., 1903. No. 53948 E.

The New Philadelphia Filtration System. H. D. Jones. An illustrated article explaining how the beds are made and how the filtering is done. 1400 w. Sci Am—March 14, 1903. No. 54084.

Fire Service.

The Relation of Water-Works Engineers to the Fire Service of Factories. Edward Atkinson. A discussion of the fire service of textile, factories, paper mills, machine shops, etc., and the need of co-operation between water-works engineers and underwriters; inspectors; meters, etc. General discussion. 12000 w. Jour N Eng W-Wks Assn—March, 1903. No. 54389 F.

Hydrants.

Hydrant Rental. D. H. Sawyer. A discussion of what is an equitable and just charge. 1800 w. Munic Engng—March, 1903. No. 53943 C.

Irrigation.

Administration of Streams in Irrigation. Elwood Mead. Considers the relation of streams to the agricultural development of the west, the meaning of a water right, etc. Also discussion. 7300 w. Jour W Soc of Engrs—Feb., 1903. No. 54149 D.

The Flood Reservoir at Fossil Creek. Illustrations, with report of this reservoir demonstrating the feasibility of this class. 900 w. Sci Am Sup—March 28, 1903. No. 54367.

Municipal Ownership.

City Ownership of Water Supply. William R. Hill. An account of the success attained at Syracuse, N. Y., as related in a paper read before the City Reform Club of New York. 2000 w. Fire & Water—March 7, 1903. No. 53952.

Organisms.

Removal of Color, Organisms, and Odor from Water. H. W. Clark. Describes some filtration experiments, the main object of which was the removal from water of coloring matter, odors, and the organisms producing odors. 3000 w. Jour N Eng W-Wks Assn—March, 1903. No. 54384 F.

Pollution.

Polluted Waters Round New York. Discusses the available sources of supply around New York city, and the pollution that renders many of the watersheds useless, especially the contamination of the Passaic in northern New Jersey. Ill. 2500 w. Fire & Water—March 7, 1903. No. 53953.

Properties.

The Physical Properties of Water. Allen Hazen. Considers the appearance of water due to foreign matters which it contains, and describes apparatus for measuring the color of water and urges the keeping records of colors and turbidity. General discussion. 4000 w. Jour N Eng W-Wks Assn—March, 1903. No. 54386 F.

Water Pipe.

Laying 6-ft. Concrete-Jacketed Riveted Steel Pipes Under the Hackensack and Passaic Rivers. Brief illustrated description of the method of submerged work used. 600 w. Eng News—March 12, 1903. No. 54091.

Standard Specifications for Cast-Iron Pipe and Special Castings. Gives the tables of special castings which were lacking in the article published in Dec., 1902, that the record may be complete. 1200 w. Jour N Eng W-Wks Assn—March, 1903. No. 54390 F.

Water Tower.

The Gorter Water Tower. Illustrated description of a "water tower" belonging to the fire apparatus of San Francisco, which has very novel features. 1500 w. Sci Am—March 14, 1903. No. 54085.

Water-Works.

Opening of the Coolgardie Water-Works. An account of these recently opened water-works of Western Australia, which, it is hoped, will greatly benefit the goldfields. Explains the needs of the gold fields, and the importance of this great undertaking. 3700 w. Engr, Lond—March 13, 1903. No. 54300 A.

MISCELLANY.

Laboratory.

The National Physical Laboratory and Engineering. Dr. R. T. Glazebrook. Lecture to the graduates of the Inst. of Mech. Engrs. Illustrates and describes the equipment of this laboratory, and suggests the work, useful to engineers, which may be done there. 4200 w. Engng—March 13, 1903. Serial. 1st part. No. 54195 A.

Sand Blasting.

Sand-Blast Cleaning of Structural Steel. George W. Lilly. Gives some of the results which have been attained, and data as to the cost and other elements entering into its application. 7500 w. Pro Am Soc of Civ Engrs—Feb., 1903. No. 53947 E.

COMMUNICATION.

Automatic Exchange.

An Automatic Telephone Operator. William J. Hammer. A description of an automatic telephone exchange operator, power driven, which performs the functions of switching, signalling, line-clearing, etc., of the human operator, and by exactly similar means. Also a comparison of the salient features of the manual and automatic systems. Ill. 7000 w. Trans Am Inst of Elec Engrs—Feb., 1903. No. 54392 D.

Cables.

Some Interesting Experiences Connected with the Manipulation and Installation of Cables. H. W. Fisher. Brief notes on telephone and electric light cables. 1000 w. Pro Engrs Soc of W Penn—Jan., 1903. No. 54153 D.

The Ratio of Resistance to Capacity in Long Submarine Cables, and Some Related Quantities. J. Elton Young. The first part of an interesting paper on the core ratio of submarine cables, with editorial. 4000 w. Elect'n, Lond—March 6, 1903. Serial. 1st part. No. 54105 A.

Cable Ships.

See Marine and Naval Engineering.

Coherer.

The Branly Coherer. C. L. Durand. An account of the Branly-Popp aerial telegraphy system which is to supply news in Paris, to subscribers. Special description of the coherer used. Ill. 1600 w. Elec Rev, N Y—March 7, 1903. No. 54028.

Detector.

A Magnetic Apparatus Adapted for the Detection of Electric Waves (Sur un Appareil à Effet Magnétique propre à Servir de Détecteur d'Ondes Electriques). C. Tissot. An account of the detector of Marconi, and the experiments of Rayleigh and Rutherford. 1200 w. Comptes Rendus—Feb. 9, 1903. No. 54211 D.

Small Exchanges.

The Relative Merits of Central Energy and Magneto Telephone Systems in Small Exchanges. W. A. Taylor. Read before the Wisconsin Ind. Telephone Assn. Calls attention to some of the advantages of each system. 1100 w. Elec Rev, N Y—Feb. 28, 1903. No. 53898.

Space Telegraphy.

Bull's Electric System of Wireless Telegraphy. A. Frederick Collins. Illustrates and describes the system of Mr. Anders Bull which operates mechanically and in which a fixed number rate of wave impulses actuate different receiving instruments in accordance with prearranged time intervals. 2000 w. Sci Am—March 21, 1903. No. 54162.

Hertzian Wave Telegraphy. Abstract of the first of a series of lectures by Prof. J. A. Fleming, before the Soc. of Arts. Aims to give a summary of the present state of knowledge on the subject. An exposition of the principles of the Hertzian wave telegraphy. 4500 w. Engng—March 6, 1903. No. 54107 A.

On a New Process for Tuning Spark Telegraph Stations. Count Arco. Abstract from *Elektrotechnische Zeitschrift*. Treats of a method of standardizing the sets of apparatus supplied to ships de sirous of communicating with differently-tuned shore stations. Ill. 1700 w. Elect'n, Lond—Feb. 27, 1903. No. 54009 A.

Portable Wireless Telegraph Equipments in the German Army. A. Frederick Collins. Illustrated description of the special apparatus constructed by the Braun-Seimens & Halske Co., to withstand the harsh treatment and strenuous conditions of army service. 900 w. Sci Am Sup—Feb. 28, 1903. No. 53845.

The Effect of Wireless Radiation on Aerial Conductor Systems. Joseph B. Baker. Refers to the troubles on telephone and telegraph lines when electric railways were first operated, and discusses some of the effects that may be caused by the energy radiated through space. 1800 w. Elec Rev, N Y—March 21, 1903. No. 54316.

Tuned Wireless Telegraph Circuits. A. V. Thiessen. Extract from a paper in the U. S. *Monthly Weather Review*, dealing with tuned circuits. 1000 w. Elec Wld & Engr—March 7, 1903. No. 54058.

Wireless Telegraphy. C. Arldt. Gives a summary of the first principles of electricity and magnetism, needed to understand the subject; illustrated descriptions of apparatus and instruments used; a brief account of Marconi's first wireless telegraph and its operation; of the Slaby, Braun, and other systems; noting the stations already established and what they have accomplished. 11000 w. Trac & Trans—March, 1903. No. 54110 E.

Wireless Telegraphy for Military Purposes. Arthur Wilke. Abstract of an article in the *Elektrotechnische Zeitschrift*. An illustrated description of Braun's Apparatus for military signalling. 2000 w. Elect'n, Lond—Feb. 27, 1903. No. 54008 A.

Switchboard.

The Evolution of the Telephone Switchboard. Thomas D. Lockwood. Historic account of the development of the telephone exchange and an analysis of the mechanical and electrical features of telephone switchboard apparatus from 1877 to date. Ill. 9000 w. Trans Am Inst of Elec Engrs—Feb., 1903. No. 54391 D.

Telephony.

Experiments in Long-Distance Telephony on the Pupin System. F. Dolezalek and A. Ebeling. From the *Elektrotechnische Zeitschrift.* Describes investigations made to ascertain to what extreme the improvement shown by theory in consequence of adding self-induction was actually attained in practice. 2000 w. Elect'n, Lond—Feb. 20, 1903. Serial, 1st part. No. 53863 A.

Discussion. A discussion of the papers by Thomas D. Lockwood and by William J. Hammer. 12,500 w. Trans Am Inst of Elec Engrs—Feb., 1903. No. 54393 D.

DISTRIBUTION.

California.

The Distribution of Bay Counties Power. The first of a series of illustrated articles showing how the power of this great corporation is to be utilized. The present article relates to Marysville and its industries. 6000 w. Jour of Elec—Feb., 1903. Serial, 1st part. No. 54111 C.

High Tension.

The Use of High Tension Underground Conductors. Henry Floy. Discusses the slow introduction of high-tension cable, the cause, the advantages, etc. 2000 w. Elec Wld & Engr—March 7, 1903. No. 54060.

Losses.

Distribution Losses in Electric Supply Systems. A. D. Constable and E. Fawssett. Abstract of a paper read before the Inst. of Elec. Engrs. Gives figures referring to the Croyden electricity works, discusses the losses and whether it is possible to reduce them. The present article considers switchboard and cable losses. 1000 w. Elect'n, Lond—March 13, 1903. Serial, 1st part. No. 54302 A.

Rectifier.

New Form of Electrolytic Apparatus for Rectifying Alternating Currents. C. L. Durand. An illustrated description of apparatus invented by M. Nodon, of Paris. 2000 w. Elec Rev, N Y—March 14, 1903. No. 54078.

Switches.

A New Spark-Preventing Device for Battery Switches (Ueber eine Neue Funkenentziehvorrichtung an Zellenschaltern). Paul Thieme. Describing the use of an auxiliary switch arrangement, preventing the sudden interruption of the current. 2000 w. Elektrotech Zeitschr—Feb. 12, 1903. No. 54235 B.

ELECTRO-CHEMISTRY.

Cells.

Solid Electrolyte Cells. A. L. Marsh. Reviews briefly the results of various experimenters and the work of the writer. 1500 w. Electro-Chem Ind—March, 1903. No. 54157 C.

Classification.

Notes on a Classification of Electro-Chemistry. Clinton Paul Townsend. Gives an outline classification dealing with the technical applications of the subject, with notes. 1500 w. Electro-Chem Ind—March, 1903. Serial, 1st part. No. 54156 C.

Electric Smelting.

Electric Manufacture of Steel. George E. Walsh. Describes the furnaces at Kerrousse, France, for the treatment of iron and steel. 1600 w. Am Elect'n—March, 1903. No. 54031.

The Electro-Metallurgical Production of Iron and Steel. Describes various designs of electric furnaces and processes which are being tried for the reduction of iron ore and direct production of steel in one operation. Ill. 1700 w. Engr, Lond—March 13, 1903. No. 54301 A.

Lake Superior.

The Industries of the Consolidated Lake Superior Company. E. G. M. Cape. An account of what this company has done, showing how its different industries are bound together. Chiefly considers the electrochemical industries on the Canadian side of the St. Mary's river. 11 plates. 9500 w. Can Soc of Civ Engrs, Adv Proof—March, 1903. No. 54142 D.

Refining.

The Electrolytic Refining of Silver and Gold. Titus Ulke. An illustrated description of different methods and some of the advantages of each. 4800 w. Mines & Min—March, 1903. No. 53977 C.

ELECTRO-PHYSICS.

Conversion.

The Conversion of Electrical Energy to Other Forms. Arthur L. Rice. Read before the James Watt Assn. Considers briefly the conversion into heat, light and mechanical motion. 1500 w. Engr, U S A—March 2. 1903. No. 53909.

Discharge.

The Electrical Conductivity and Absorption of Energy in the Electrodeless Discharge. Bergen Davis. An illustrated account of experiments made to measure the conductivity produced in gases by the

We supply copies of these articles. See page 317.

discharge at various pressures. 1300 w. Am Jour of Sci—March, 1903. No. 53940 D.

Magnetism.

The Causes of Magnetism (Die Ursachen des Magnetismus). T. Zacharias. A study of magnetic curves produced with metal filings, with a discussion of the laws of their formation. 3000 w. Glasers Annalen—March 1, 1903. No. 54226 D.

Magnets.

The Effects of Changes of Temperature on Permanent Magnets. Hiram B. Loomis. An account of some experiments undertaken to determine more accurately the kind of change that takes place when a magnet is heated and cooled after it has been brought to the "permanent state." 4800 w. Am Jour of Sci—March, 1903. No. 53939 D.

Radio-Activity.

Radium—Its Extraordinary Properties. C. W. Kanolt. An interesting account of the discovery, the properties, cost, and action. 1800 w. Sci Am—Feb. 28, 1903. No. 53842.

The Radiations of Polonium and Radium (Sur la Rayonnòment du Polonium et du Radium). H. Becquerel. An examination of the experiments of Rutherford as to the deviability of the rays from radiant metals; with an account of the writer's experiments. 1800 w. Comptes Rendus—Feb. 16, 1903. No. 54212 D.

Resonance.

A Study of the Phenomenon of Resonance in Electric Circuits by the Aid of Oscillograms. M. B. Field. Abstract of a paper read before the Glasgow Soc. of the Inst. of Elec. Engrs. The present number considers the conditions under which electric resonances may occur. 2000 w. Elec Rev, Lond—March 6, 1903. Serial, 1st part. No. 54102 A.

GENERATING STATIONS

Commutators.

Some Notes on Commutator Design. T. Square. Considers the electrical conditions to be satisfied, and also the mechanical features. Ill. 4200 w. Elec Engr, Lond—March 13, 1903. No. 54189 A.

Eastbourne.

Eastbourne Electricity Works. Illustrated detailed description of new English works. 4200 w. Elec Engr, Lond—March 6, 1903. No. 54100 A.

Hydro-Electric.

A Hydro-Electric Power Plant in Newfoundland. Earl E. Boardway. Brief illustrated description of the plant which furnishes power for St. John's, nine miles distant. 1000 w. Elec Wld & Engr—March 7, 1903. No. 54057.

A Swiss Combined Water-Power and Gas Engine Plant. An illustrated description of a water-power station at Goldach with auxiliary gas-engine plant at St. Gall. 2000 w. Am Elect'n—March, 1903. No. 54029.

A Water-Power Plant Near Grenoble, France. Brief description of a plant, chiefly interesting from the fact that it uses a hooped-steel concrete conduit for conducting the water. 2500 w. Eng Rec—March 7, 1903. No. 54051.

Rise of Water Power in Electrical Supply. Alton D. Adams. Shows the development of water power for electrical supply to be gaining very rapidly, giving information of the transmission systems. 1000 w. Sci Am—March 28, 1903. No.54365.

The Hydro Electric Station of Côtes de Sassange (Usine Hydro-Electrique des Côtes de Sassange). A. Mauduit. Describing a small station on the Isère above Grenoble, utilizing a head of 135 metres; operating in connection with the larger station at Engins. 1800 w. Génie Civil—March 7, 1903. No. 54205 D.

Water-Power Electric Plant at Manchester, Conn., for the Cheney Bros.' Silk Mills. Earl E. Boardway. An illustrated detailed description of this plant. 1500 w. Eng News—March 19, 1903. No. 54306.

Isolated Plant.

Power Plant of the Wells Building, Milwaukee. Illustrates and describes a fine plant installed in a high office-building, and having a capacity about double of the requirements of the building, to furnish lighting and steam service to neighbors. 3200 w. Engr, U S A—March 2, 1903. No. 53908.

Parallel Driving.

The Pendulum Action of Alternators in Parallel (Das Pendeln Parallel Geschalteter Wechselstrommaschinen). Dr. G. Benischke. A discussion of the analogy of the phenomena of alternators in parallel to the oscillations of pendulums. 4000 w. Elektrotech Zeitschr—March 12, 1903. No. 54239 B.

Power House Equipment.

Some Notes on Continental Power-House Equipment. H. L. Riseley. Read before the Newcastle Sec. of the Inst. of Elec. Engrs. Illustrated description of stations examined during a recent visit. 4800 w. Elec Engr, Lond—Feb. 20, 1903. No. 53866 A.

Stock Yards.

Swift & Co.'s Chicago Central Power Plant. An illustrated description of a 2800 H. P. electric generating station at the Union Stock Yards. 3500 w. Steam Engng—March 10, 1903. No. 54073.

See also Street and Electric Railway.

LIGHTING.

Arcs.

Flame Arc Lamps and Intensive Flame Arc Lamps of the A. E. G. (Flammenbogen lampe und Intensivflammenbogen lampen der Allgemeinen Electrizitäts-Gesellschaft). J. Zeidler. A description of improved arc lamps of high efficiency, using impregnated carbons. 4000 w. Elektrotech Zeitschr—Feb. 26, 1903. No. 54237 B.

Delhi.

Electric Lighting at the Delhi Durbar. Brief illustrated description of the arrangements for electric lighting of this temporary city, showing the magnitude of the undertaking. 1200 w. Elect'n, Lond—March 6, 1903. No. 54103 A.

Dublin.

Some Notes on the Electric Lighting of Rathmines. G. H. Pilditch. Read before the Dublin Sec. of the Inst. of Elec. Engrs. A description of the important details of the lighting system of a suburb of Dublin. 5500 w. Elec Engr, Lond—Feb. 27, 1903. No, 54005 A.

Mercury Arc.

Radient Efficiency of the Mercury Arc. Prof. William C. Geer. Condensation of a paper in the Feb. issue of the *Physical Review,* giving results of investigations. 1200 w. Elec Wld & Engr—Feb. 28, 1903. No. 53955.

Municipal Lighting.

Municipal Electric Lighting Opposed. James Blake Cahoon. Read at Nat. Con. on Munic. Ownership and Pub. Franchises. A discussion of the trials made in the United States and the conclusions reached. 4000 w. Elec Rev, N. Y.—March 14, 1903. No. 54076.

Nernst Lamp.

The Nernst Lamp. Abstract of a paper by J. Stöttner, and of the discussion. Also gives an abstract of a report of tests made of Nernst lamps for street lighting. 5000 w. Elect'n, Lond—March 6, 1903. No. 54104 A.

Street Lighting.

Incandescent Street Lighting. Alton D. Adams. Information in regard to the incandescent electric lamps used for street lighting in Massachusetts, and the value of the service. 1300 w. Munic Engng—March, 1903. No. 53942 C.

Street Lighting Conditions in New York City and a Proposed Municipal Plant. Reprint of two reports submitted to the Board of Estimate and Apportionment of New York City, with account of steps being taken to secure municipal ownership of the lighting service, or marked reduction in the cost. 7500 w. Eng News—March 19, 1903. No. 54308.

MEASUREMENT.

Alternating Currents.

A Method of Measuring Powerful Alternating Currents (Sur une Methode de Mesure des Courants Alternatifs Intenses). MM. Janet & Illovici. A description of the work done at the Central Electrical Laboratory, using a modification of the Kelvin balance. 7000 w. Bull Soc Int Elec—Feb., 1903. No. 54277 H.

Electroscope.

Elster and Geitel's Improved Form of Exner's Electroscope. A. Frederick Collins. Illustrated description of apparatus adapted for open air researches. in determining the radio-activity of air and indicating the electrification. 1400 w. Elec Wld & Engr—March 7, 1903. No. 54059.

Meter Testing.

The Testing of Recording Wattmeters on the Consumer's Premises by Means of a Specially Constructed Portable Test Meter. W. J. Mowbray. Describes a method of testing meters in place, by using a peripatetic standard meter similar to the meter tested. Ill. 3200 w. Elec Wld & Engr—March 21, 1903. No. 54311.

Permeability.

The Investigation of Sheet Iron (Zur Untersuchung von Eisenblechen). Dr. G. Brion. An account of methods for investigating the magnetic properties of sheet iron, with respect to its use in electrical machinery. 2000 w. Elektrotech Zeitschr—March 5, 1903. No. 54238 B.

Permeameter.

A Universal Permeameter (Permeametre Universel). R. V. Picou. Giving details of the connections and methods of using the instrument, by means of which the magnetic permeability of iron for use in electrical machinery may be accurately determined. 2000 w. L'Electricien—Feb. 21, 1903. No. 54273 B.

Photometry.

Notes on Working with an Illumination Photometer. Henry Fowler. Read before the Manchester Dist. Inst. of Gas Engrs. On types of photometers and methods of using them. 3800 w. Gas Wld—March 14, 1903. No. 54187 A.

Working an Illumination Photometer. Henry Fowler. Read before the Manchester Dist. Inst. of Gas Engrs. Addendum to a previous paper, giving record of curves of outdoor and indoor lighting. Discussion. 2400 w. Jour Gas Lgt—March 17, 1903. No. 54400 A.

Speed Indicator.

A New Speed Indicator (Ein Neuer Geschwindigkeitsmesser). G. Dettmar. Describing a device for indicating directly the speed of a railway train, or the like. A small dynamo is arranged so that the voltage varies directly as the speed, and is connected to a voltmeter graduated to read the speed directly. 2000 w. Glasers Annalen—March 1, 1903. No. 54224 D.

Testing.

The Magnetic Link in Plant Testing. George S. Macomber. Briefly describes the method of testing and the auxiliary apparatus necessary. 2000 w. Sib Jour of Engng—March, 1903. No. 54151 C.

Units.

A Modification in the System of Absolute Units (Ueber eine Aenderung des Absoluten Masssystemes). Dr. G. Dompieri. A discussion of the absence of uniformity in the units of mass and time, with suggestions as to a new two-dimensional system. 2500 w. Zeitschr f Elektrotechnik—March 8, 1903. No. 54243 D.

POWER APPLICATIONS.

Canal Traction.

Electric Haulage on the Miami & Erie Canal. An illustrated detailed description of the first three-phase traction system in the United States. The most extensive application of mechanical canal-boat haulage yet installed. Also editorial. 5300 w. St Ry Rev—March 20, 1903. No. 54338 C.

The New Ganz System of Electric Canal Haulage. G. Szasz. An illustrated description of the main characteristics of this system. 5500 w. Feilden's Mag—March, 1903. No. 54369 B.

Electric Motors.

The Development and Use of the Small Electric Motor. Fred M. Kimball. The first of a series of articles treating of the applications of electric motors of moderate size in all branches of engineering work. The present article discusses progress in design, introduction, and running economy, and is profusely illustrated. 4000 w. Engineering Magazine—April, 1903. No. 54284 B.

The Electric Motor. A. E. MacCoun. From Boston *Journal of Commerce*. Gives facts showing how the use of electricity is being developed about steel works and blast furnaces. 1500 w. Sci Am Sup—March 7, 1903. No. 53970.

Induction Motors.

The Heyland Induction Motor. Boy de la Tour. Reprint of a chapter specially written for the American edition of the author's work. Explains the nature of this invention and gives a method of calculation for a machine designed to meet certain requirements. 1500 w. Elec Wld & Engr—March 14, 1903. No. 54122.

Machine Driving.

Electric Shop Drive. W. R. Layman. Outlines the various methods of electric shop driving; introductory to a general discussion of their relative merits. 8200 w. Jour Assn of Engng Socs—Jan., 1903. No. 54159 C.

The Application of Motors to Machine Tools. Charles Day. Supplementary to paper read before the N. Y. Elec. Soc. Discusses some details bearing upon the equipping machines with individual motors. 1400 w. Am Mach—March 26, 1903. No. 54357.

The Possible Developments of Electrical Driving in Factories Due to the Supply of Electricity at Cheap Rates by Large Power Companies. J. S. Highfield. Abstract of paper before the Manchester Sec. of the Inst. of Elec. Engrs. A discussion of cost, advantages, and matters relating to electric driving. 4000 w. Prac Engr—Feb. 27, 1903. Serial. 1st part. No. 53992 A.

Mine Pumps.

Electric Mine Pumping at the Gneisenau Shaft (Elektrische Wasserhaltungsanlage auf Zeche Gneisenau). K. Nowak. A description of the 640 h. p. electric pumping plant, with induction motor, at the Gneisenau mine near Dortmund. 1500 w. Glückauf—Feb. 28, 1903. No. 54232 D.

Mining Work.

Application of Electricity to Mining. Daniel Burns. Read before the Glasgow Tech. Col. Sci. Soc. Deals with some of the more important applications of electricity for mining purposes, such as lighting; driving machinery; coal-cutting; drilling; separating minerals; shot-firing; signalling, etc. 1700 w. Col Guard—Feb. 20, 1903. Serial. 1st part. No. 53874 A.

Electrical Mining Notes. Sidney F. Walker. The present article considers the uses of electricity in British collieries. 2000 w. Elec Rev, N. Y.—March 14, 1903. Serial. 1st part. No. 54075.

Electricity in Modern Mining Drainage Installations. Frank C. Perkins. An illustrated article concerning the reliability and economy of electrically operated pumps, and the use of electricity for mine haulage, hoisting, etc. 1500 w. Sci Am—March 28, 1903. No. 54366.

Motor Design.

Design for a ½-H. P. Self-Starting Single-Phase Induction Motor. Drawings and description of all the essential features. 1800 w. Am Elect'n—March, 1903. No. 54032.

Motor Loads.

Motive Power Supply from Central Stations. R. A. Chattock. Abstract of a paper before the Leeds Sec. of the Inst. of Elec. Engrs. and of the discussion. Treats of the motor load of electricity supply stations and the cost of generation. 3500 w. Elect'n, Lond—Feb. 27, 1903. No. 54010 A.

Naval Service.

See Marine and Naval Engineering.

Railway Station.

Power Equipment of the Pennsylvania Union Station, Pittsburg. Drawings and description of interesting features. 2200 w. Eng Rec—March 21, 1903. No. 54327.

Synchronous Motors.

An Analysis of the No-Load Current of Synchronous Motors (Analyse des Leerlaufstrommes von Synchronmotoren). E. Rosenberg. With diagrams showing the variations in phase curves under different conditions. 3000 w. Elektrotech Zeitschr—Feb. 12, 1903. No. 54234 B.

See also Street and Electric Railways.

TRANSMISSION.

Circuits.

Copper Calculations for Polyphase Circuits. George T. Hanchett. Gives methods of computing for various cases. 1300 w. Cent Sta—March, 1903. No. 54071.

Composite Transmission.

Some Engineering Features of the Bedell System of Composite Transmission. A. S. McAllister. Gives illustrated detailed description of methods for the joint transmission of direct and alternating currents of two frequencies. Also editorial. 3000 w. Elec Wld & Engr—Feb. 28, 1903. No. 53954.

Conductors.

Electric Transmission Lines. Alton D. Adams. A discussion and comparison of line wire materials. 3500 w. Cassier's Mag—March, 1903. No. 54137 B.

Continuous Current.

Continuous Current for Power Transmission. Alton D. Adams. Considers systems of transmission by continuous current, showing that they should cost less for equipment than the alternating for power alone, and discussing their advantages. 3000 w. Elec Rev, N. Y.—March 21, 1903. No. 54315.

Five-Phase.

A Theoretical Treatment of a Five-Phase System (Theoretische Behandlung eines Fünfphasenstromsystemes). E. W. Ehnert. An application of the vector analysis to the study of a proposed polyphase system. 2500 w. Zeitschr f Elektrotechnik—Feb. 15, 1903. No. 54241 D.

High Tension.

The 22,000-Volt Transmission Installation Supplying Current to Mines by the Northern California Power Company. Frank C. Perkins. Illustrated description of a recently completed high tension service in Northern California. 1700 w. Min Rept—March 26, 1903. No. 54396.

Insulators.

The Use of Porcelain in the Manufacture of High and Low Tension Switchgears. W. E. Warrilow. On the importance of this product as an insulator. 2000 w. Elec Engr, Lond—March 13, 1903. No. 54190 A.

MISCELLANY.

Protection Device.

A Protecting Device Against the Dangers of High Voltage Currents (Ueber eine Schutzkleidung gegen die Gefahren Hoher Spannungen). N. Artemieff. Describing a garment with hood and sleeves of woven metallic fabric, preventing the discharge from injuring the operator. 2000 w. Elektrotech Zeitschr—March 12, 1903. No. 54240 B.

Report.

Safety Regulations for the Installation of Heavy Currents (Sicherheitsvorschriften für die Errichtung Elektrischer Starkstromanlagen). The report of the commission of the Verband Deutscher Elektrotechniker. 10,000 w. Elektrotech Zeitschr—Feb. 19, 1903. No. 54236 B.

GAS WORKS ENGINEERING

Acetylene.

Acetylene. John W. Woodall and F. Windham. Read before the Soc. of Architects. Gives the history and chemical composition of carbide of calcium from which the gas acetylene is generated, and the system of generators, costs, installations, etc. 3200 w. Archt, Lond—Feb. 20, 1903. No. 53862 A.

Ammonia.

Ammonia Concentration at Gas Works. John S. Unger. Read at meeting of the Wisconsin Gas Assn. Illustrates and explains a suitable apparatus for ammonia concentration, and its operation. 1600 w. Am Gas Lgt Jour—March 2, 1903. No. 53891.

Artificial Lighting.

Artificial Lighting in the Nineteenth Century. Abstract of a paper by D. Macfie, read before the Edinburgh Archt. Assn. Mainly historical with special reference to Edinburgh. 3500 w. Jour Gas Lgt—March 10, 1903. No. 54179 A.

Cyanogen.

German Progress in the Recovery of Cyanogen from Gas. Substance of articles recently appearing in German technical journals, notably the *Jour. für Gasbeleuchtung*, dealing with processes for the extraction of cyanogen from coal gas. 4000 w. Jour Gas Lgt—Feb. 24, 1903. Serial. 1st part. No. 53958 A.

Edinburgh.

Edinburgh's New Gas Works. An illustrated description of the first section of these fine works, recently opened. 3800 w. Gas Wld—Feb. 28, 1903. No. 54000 A.

Fischer System.

The Fischer Air-Gas System. Illustration, with description, of a plant for generating a gas by carburetting air with heavy tar oils—especially benzol—in a refined or unrefined state, claimed to be the cheapest illuminating medium known. 1800 w. Jour Gas Lgt—March 3, 1903. No. 54044 A.

Gas Coke.

The Coke Plant at the Smethwick Gas-Works. Illustrated description of a gravity bucket conveyor for feeding a water-gas plant. 4500 w. Jour Gas Lgt—March 3, 1903. No. 54043 A.

High Pressure.

Distributing Artificial Gas Under High Pressure. George F. Goodnow. Read before the Wisconsin Gas Assn. Notes relating to observations and experience during the past year, difficulties overcome, and methods used. 2200 w. Pro Age—March 16, 1903. No. 54070.

Recent Developments in High-Pressure Gas Lighting. Scott Snell. Report of a lecture before the Royal Scottish Soc. of Arts. Especially explaining the merits of the writer's system. 1600 w. Gas Wld—Feb. 28, 1903. No. 54001 A.

Meters.

Premature Corrosion of Wet Gas Meters. A. Albrecht, in *Journal für Gasbeleuchtung*. Summary. Considers the use of saline solutions in the meter, for sealing, for preventing freezing, or for thawing, to be the main cause, and suggests the remedy. 2000 w. Gas Wld—March 14 1903. No. 54188 A.

Pipe Corrosion.

An Electrical Disturbance in the Gas Industry. D. D. Barnum. Read before the New England Assn. of Gas Engrs. An account of a leakage in a gas main, in Worcester, Mass., due to electrolysis. 1400 w. Am Gas Lgt Jour—March 23, 1903. No. 54317.

Smethwick.

Combined Oil-Carburetted and Blue Water-Gas Plant at Smethwick. Illustrates and describes the novel features of this recently installed plant. 2800 w. Jour Gas Lgt—March 10, 1903. No. 54177 A.

Street Lighting.

Street-Lighting. Tabulated reports by J. W. Bradley, of tests made of a great variety of systems and their cost, including both gas and electricity. 1700 w. Elec Engr, Lond—Feb. 20, 1903. No. 53868 A.

Tar.

Tar Fog. William Everitt. Read before the Manchester Dist. Inst. of Gas Engrs. A description of apparatus tried by the writer, with general discussion. 5500 w. Jour Gas Lgt—March 10, 1903. No. 54-178 A.

INDUSTRIAL ECONOMY

Accounting.

Comparative Statements. Henry W. Brooks, Jr. On the importance of intelligent accounting, and the value of comparative statements showing the results of any change in policy or methods. Refers chiefly to street railway work. 2500 w. St Ry Rev—March 20, 1903. No. 54340 C.

The General Principles of Mine Accounting. E. Jacobs. A comparison of the engineering methods of mining with the corresponding business principles applicable to the recording and accounting work of the commercial side. 3000 w. Engineering Magazine—April, 1903. No. 54286 B.

Coal Strike.

The Anthracite Commission. Extracts from the report on the awards of the Commission, with editorial. 6000 w. Ir Age—March 26, 1903. No. 54335.

Copper Trade.

The World's Copper Trade. Horace J. Stevens. A review of the production and trade conditions for the year 1902 and prospects for 1903. 3300 w. Mines & Min—March, 1903. No. 53980 C.

Cost Keeping.

Cost Finding Methods for Moderate Sized Shops. Kenneth Falconer. A general account of the system used by the Canadian Composing Company, engaged in the manufacture of type composing machines; giving details and forms used. 2500 w. Engineering Magazine—April, 1903. No. 54288B.

Education.

Theory and Practice of Correspondence Schools. Frank McManamy. An explanation of the methods of instruction, especially in railway work. 2100 w. St. Louis Ry Club—Feb. 13, 1903. No. 53938.

Grain Traffic.

Great Lakes Grain Traffic. R. J. Donovan. An illustrated account briefly describing the elevator, the operations necessary in the handling of the grain, and the vessels engaged in the trade. 3000 w. Marine Engng—March, 1903. No. 53984 C.

Iron Trade.

The Export Trade of the German Iron Industry in 1902 (Der Aussenhandel der Deutschen Eisenindustrie in Jahre, 1902). Statistics, tables, and graphical diagrams, covering the past ten years. 1000 w. 3 plates. Stahl u Eisen—Feb. 15, 1903. No. 54245 D.

The Future of American Iron Costs. B. E. V. Luty. A study of the low prices of a few years ago, discussing how far they are likely to return. Also editorial. 4000 w. Ir & Coal Trds Rev—March 13, 1903. No. 54333 A.

Labor.

Issues Between Employers and Employees. Summary of actions taken by various organizations, including a new movement which has for its object the maintenance of the right of the individual to work when and under what terms he pleases. 3500 w. Ir Trd Rev—March 26, 1903. No. 54399.

Labor Crisis in the Scotch Shipbuilding Industry. A statement of the situation due to the wages controversy in the shipbuilding and engineering industries. 1800 w. Ir Age—March 12, 1903. No. 54022.

Labor Management.

The Working of a Labor Department in Factory Management. Charles U. Carpenter. A discussion of the importance of meeting labor questions at the earliest possible stage, and thus stopping troubles before they begin. 3500 w. Engineering Magazine—April, 1903. No. 54281 B.

Labor Organizations.

The Courts on Organized Labor. James A. Miller, Reprint from Volume II, No. 1, *Bulletin Corporations Auxiliary Company,* Cleveland, O. The article aims to encourage resort to the courts in labor troubles. Discusses the "right to parade," "picketing," the sympathetic strike, and injunctions. 6000 w. Ir Age—March 5, 1903. No. 53905.

The Rights and Methods of Labor Organizations. Albert S. Bolles. Discusses misconceptions that are somewhat general, explaining the attitude of many labor organizations, and the spirit of ill-will of employees toward employers, giving conclusions. 4500 w. N Am Rev—March, 1903. No. 53931 D.

Municipal Ownership.

Recent Attacks on Municipal Ownership in Great Britain. Robert Donald. Abstract of paper read at Nat. Con. on Munic. Ownership & Pub. Franchises. A review of municipal and engineering enterprise in England. 2000 w. St Ry Jour—March 7, 1903. No. 54067 D.

Municipal Trading.

European and American Methods and Results Compared. Robert P. Porter. Abstract of a paper at the Nat. Con. on Munic. Ownership & Pub. Franchises. Reviews the conditions briefly, but thinks a comparison hardly possible as the laws and needs so differ. 2800 w. St Ry Jour—March 7, 1903. No. 54068 D.

Profit Sharing.

The Steel Corporation Points the Way. Walter Wellman. An explanation and discussion of the wage earners' investment and profit-sharing plan, which was received with success. 6000 w. Rev of Revs—March, 1903. No. 53935 C.

Shipping.

The Present Position of British Shipping. Benedict W. Ginsburg. Discusses the rise and progress of British shipping with special reference to the Atlantic Shipping Trust and the effect of foreign subsidies. 4000 w. Page's Mag—March, 1903. Serial, 1st part. No. 54377 B.

Small Manufacturers.

The Problem of the Smaller Manufacturers of Rods and Merchant Bars. William Garrett. The writer's views on the prospects of getting raw material, and being able to compete with the United States Steel Corporation. Gives plans and discusses cost. 3800 w. Ir Trd Rev—March 5, 1903. No. 53959.

Unit Costs.

Recording Unit Costs of Contract Work. Emile Low. Considers the keeping of such accounts very desirable, and gives experience and methods used. 1500 w. Eng News—March 26, 1903. No. 54361.

Water Supply.

Duties of Municipalities Regarding Water Supply. Hon. J. O. Hall. Shows it to be the duty of the municipality to supply a generous amount of pure water for domestic uses, etc. 5600 w. Jour N Eng W-Wks Assn—March, 1903. No. 54385 F.

Workmen's Homes.

Working People's Homes. D. A. Tompkins. An explanation of the advantages of the building and loan system for the benefit of working people. 6200 w. Ill. Cassier's Mag—March, 1903. No. 54135 B.

MARINE AND NAVAL ENGINEERING

British Navy.

Great Britain's Naval Supremacy. Archibald S. Hurd. Reviews the changed conditions which have required a change in policy and gives a table showing the forces ready for defence and the growth which has taken place. Ill. 4000 w. Cassier's Mag—March, 1903. No. 54134 B.

Cable-Ships.

The Cable-Ships "Restorer" and "Patrol." Illustrated descriptions of two recently completed vessels which represent the most modern practice, and possess interesting details due to their being intended for repairing rather than laying cables. 2500 w. Elect'n, Lond—Feb. 27, 1903. Serial. 1st part. No. 54007 A.

Cruiser.

Argentina Cruiser Moreno. Illustration and brief description of a vessel of the Garibaldi type, with comparison with other vessels of the size. 800 w. Engr, Lond—March 6, 1903. No. 54108 A.

Destroyer.

The Contract Speed Trial of U. S. Torpedo Boat Destroyer "Stewart." Albert Moritz. Illustration, description, and report of trial. 3500 w. Jour Am Soc of Nav Engrs—Feb., 1903. No. 54170 H.

Dredges.

See Civil Engineering, Canals, Rivers, and Harbors.

Electricity.

Use of Electricity on German Vessels. Illustrations, with brief description of the uses to which electricity is applied on the "Kronprinz Wilhelm." 600 w. U S Cons Repts, No. 1587—March 6, 1903. No. 53-907 D.

Fireboat.

New York Fireboat. Illustrated description of the fireboat designed by H. de B. Parsons, and its equipment. 1500 w. Marine Engng—March, 1903. No. 53985 C.

Fire Extinguishing.

Fire Extinguishing Apparatus for Ships. John H. Heck. Read before the N. E. Coast Inst. of Engrs. & Shipbuilders. Reviews various methods that have been tried, and describes briefly the Clayton fire extinguisher. Ill. 2000 w. Engrs' Gaz—March, 1903. No. 54042 A.

Floating Docks.

Floating Drydocks—Their Military Possibilities and Value. John D. Ford. An illustrated discussion of the construction, cost, advantages and value of drydocks, giving detailed description of the drydock at New Orleans. 5000 w. Jour Am Soc of Nav Engrs—Feb., 1903. No. 54165 H.

The Evolution of the Floating Dock. An illustrated historical review. 2000 w. Engrs' Gaz—March, 1903. Serial. 1st part. No. 54041 A.

Labor.

See Industrial Economy.

Launches.

Steam Launches for the War Department. Illustrated detailed description of two 45-foot steam launches recently finished. 1800 w. Marine Engng—March, 1903. No. 53988 C.

Marine Boilers.

See Mechanical Engineering, Steam Engineering.

Marine Engines.

See Mechanical Engineering, Steam Engineering.

Monitor.

Contract Trial of the U. S. S. Wyoming. W. W. Bush. Illustration and description of the vessel with report of trial. 6000 w. Jour Am Soc of Nav Engrs—Feb., 1903. No. 54169 H.

Oil Fuel.

See Mechanical Engineering, Steam Engineering.

Scotch Practice.

Some Useful Data from Scotch Marine Engineering Practice. H. Wilkes. Table and diagrams giving figures based upon engines, boilers and accessories actually constructed in Scotch shipyards. 600 w. Eng News—Feb. 26, 1903. No. 53851.

Shipping.

See Industrial Economy.

Small Boats.

The Powering and Propulsion of Small Boats. W. F. Durand. A general discussion of methods for determining the amount of power required for the propulsion of small boats at a desired speed. 3800 w. Marine Engng—March, 1903. No. 53986 C.

Steamships.

The Size of Steamships: Its Relation to Speed and Cargo-carrying Capabilities. Sidney Graves Koon. Discusses the characteristics of cargo steamers which might be designed for service between New York and London, describing a type-ship and discussing the economical performance. 2200 w. Sib Jour of Engng—Feb., 1903. No. 53936 C.

Submarines.

Official Trials of Submarine Boats Adder and Moccasin. William Russell White. Brief description with detailed report of trials and general comments upon the behavior and possibilities of the boats. Ill. 5200 w. Jour Am Soc of Nav Engrs—Feb., 1903. No. 54167 H.

Torpedoes.

The Modern Torpedo. Gustave Hubert. An illustrated detailed description of the Whitehead torpedo, with remarks on its value in warfare. 2700 w. Page's Mag—March, 1903. No. 54374 B.

U. S. Navy.

Our Actual Naval Strength. George W. Melville. Discusses the resources of the United States that strengthen the power of the navy, and shows the wisdom of providing for a strong and efficient navy. 6500 w. N Am Rev—March, 1903. No. 53-930 D.

Yachts.

Shamrock III. A brief description of the latest yacht built for America cup racing. 1300 w. Sci Am—March 21, 1903. No. 54161.

MECHANICAL ENGINEERING

AUTOMOBILES.

Commercial Vehicles.

Commercial Self-Propelled Vehicles. Walter L. Bodman. An illustrated article considering the advantages of the motor wagon over horse-drawn vehicles with details of a proposed type of steam commercial vehicle. 1500 w. Automobile—March 7, 1903. No. 54018.

Cylinder Cooling.

Radiator Area per Horse Power in the Modern Gasoline Automobile. Herbert L. Towle. Gives results of a partial canvas of the more important machines at the Madison Sq. Garden show, showing the best machines have from 4 to 6 square feet of cooling surface per horse power. 2000 w. Automobile—Feb. 28, 1903. No. 53881.

Cylinder Jackets.

Experiments with Non-Freezing Liquids—A New Solution Proposed for Cylinder Jackets. E. Mallinckrodt, Jr. An account of experimental investigations made with a solution of calcium chloride under conditions similar to those obtaining in the circulation system of an automobile. 1500 w. Horseless Age—March 4, 1903. No. 53960.

Exhibits.

Technical Notes on Exhibits at Some Recent English Shows. J. S. V. Bickford. A summary of interesting points observed in late models of motor cycles and cars. Ill. 2800 w. Horseless Age—Feb. 25, 1903. No. 53841.

Gasoline Cars.

Data on Gasoline Touring Cars. J. G. Perrin. A comparison of data in the leading types exhibited at the recent exhibition in New York. 1200 w. Horseless Age—Jan. 28, 1903. No. 54040.

Ignition.

Constructing a Jump Spark Coil. George T. Hanchett. Discusses the troubles due to defective coils for ignition in explosion motors, and their remedy in the adoption of modern methods of construction. Ill. 4000 w. Automobile—March 14, 1903. No 54072.

The Eisemann System of Magneto Ignition. Illustrated description of a system of ignition in which the spark is produced by means of a high tension current, brought about by a rotary magneto machine working in conjunction with an induction coil without a trembler. 1600 w. Autocar—Feb. 21, 1903. No. 53870 A.

Kerosene Engine.

A Fuel Oil or Kerosene Engine. Marius C. Krarup. Problems in the construction of stationary and automobile motors studied in the Ostergren two-cycle engine, with liquid fuel injection, high compression and gradual combustion. Ill. 3500 w. Automobile—March 21, 1903. No. 54155.

Lamps.

Lamps for Fast Night Travel. Illustrated description of searchlights adapted to the needs of motorists. 1500 w. Automobile—Feb. 28, 1903. No. 53880.

Lubrication.

To Prevent Short Oil Pipes Robbing Long Ones. Thomas Clarkson. Extracts from a paper read at a meeting of the Automobile Club of Great Britain and Ireland. Gives statements of interest in regard to lubrication in automobiles. 900 w. Automobile—March 7, 1903. No. 54-019.

Mail Van.

His Majesty's Mail by Motor Van. Gives a copy of the general report concerning the service of postal vans between Manchester and Liverpool, with illustrations and remarks. 2000 w. Auto Jour—March 7, 1903. No. 54098 A.

Novelties.

Automobile Novelties (Les Nouveautés en Automobile). M. Miral. Describing details of machines shown at the Salon de l'Automobile of December, 1902, including an automobile fire engine, improved transmissions, etc. 2500 w. Revue Technique—Feb. 25, 1903. No. 54208 D.

Omnibus.

Electric Omnibuses for London. J. Sutherland Warner. Aiming to show how properly designed electric vehicles, operated systematically, could be made profitable; outlining the scheme. 2800 w. Elec Times—March 5, 1903. No. 54096 A.

Petrol Cars.

The Earl Petrol Car. Brief illustrated description of a 9 h. p. petrol vehicle, weighing about 15 cwt., with photographs of the chassis, showing the driving mechanism. 1500 w. Auto Jour—Feb. 21, 1903. No. 53871 A.

The Cottereau Petrol Vehicles. Illustrates and describes the interesting features of the various sizes made, with details of engines and carburetter. 1800 w. Auto Jour—March 7, 1903. No. 54097 A.

The Mandslay 1903 Petrol Car. Illustrated description of characteristic features of a heavy and powerful car, with photographs of the engines and gearing. 4000 w. Auto Jour—March 14, 1903. No. 54-185 A.

Reviews.

The Automobile Vehicle in 1902 (La Voiture Automobile en 1902). F. Drouin. An illustrated review of the exhibitions, trials, and constructive development of the automobile in 1902; with especial reference to French designs. Three articles. 8000 w. Génie Civil—Feb. 21, 28, March 6, 1902. No. 54203 each D.

Steam Cars.

A New Steam Motor Car. Illustrates and describes the Clarkson car. It is a substantial and roomy machine, in which paraffine oil can be used as a fuel. 1800 w. Engr, Lond—March 13, 1903. No. 54198 A.

The Latest Locomobile Steam Cars. Illustrates and describes a brougham, dos-a-dos, and surrey; also the shops of the company. 3200 w. Auto Jour—Feb. 28, 1902. No. 54002 A.

The Recent Development in Light Steam Cars. Filson Young. Some remarks on the development in steam cars and the latest types. 1700 w. Autocar—March 14, 1903. No. 54186 A.

Tools.

Automobile Machine Tools. George E. Walsh. Discusses the outlook for the automobile industry, the need of standardization and the design of special tools. 2000 w. Ir Age—March 12, 1903. No. 54023.

Trials.

Paris Fuel Consumption Trials Organized by "L'Auto." An account of this year's trials, with illustrations of the vehicles. 700 w. Auto Jour—Feb. 28. 1903 No. 54003 A.

Variable Speed.

Motor Driven Truck Having Novel Variable Speed Mechanism. Diagram and description of the construction of the variable-speed gear of a machine exhibited in the late automobile show, in New York. 1200 w. Mach, N Y—March, 1903. No. 53990.

The Simplex Gradual Variable-Speed Gear. Illustrated description of the mechanism invented by W. N. Dumaresq. 2500 w. Auto Jour—March 7, 1903. No. 54-099 A.

The Germain Electric Change-Speed Gear. Remarks on the various petrol-electric systems, and gives detailed illustrated description of the Germain system, pointing out some of the advantages of devices of this kind. 2000 w. Auto Jour—Feb. 21, 1903. No. 53872 A.

HYDRAULICS.

Bordeaux.

Extension of the Hydraulic Plant at the Port of Bordeaux (Agrandisement de l'Usine Hydraulique du Port de Bordeaux). A general account of the pumps, accumulators, and arrangement of the plant used to operate the hydraulic cranes at the port of Bordeaux, France. 3000 w. 1 plate. Génie Civil—Feb. 21, 1903. No. 54202 D.

Electric Pumping.

See Electrical Engineering, Power Applications.

Governor.

Hydraulic Regulator for Turbines (Hydro-Tachymètre pour Régulateur de Turbines Hydrauliques). L. Ribourt. A description of the writer's turbine governor, acting by variations in the pressure of a stream of water. 1200 w. Comptes Rendus—Feb. 23, 1903. No. 54213 D.

Hydraulic Cylinders.

The Strength and Proportion of Hydraulic Cylinders. Frank B. Kleinhans. Considers method of determining the thickness of the wall needed. Ill. 900 w. Am Mach—March 26, 1903. No. 54356.

Hydro-Electric Stations.

See Electrical Engineering, Generating Stations.

Pumping Engine.

Old Pumping Engine at the New York Navy Yard Dry Dock. Illustrates and describes an engine of the double-acting beam type, built when large engines were few, which has recently been replaced by two centrifugal pumps which drain the dock in half the time, and occupy about one-tenth the space. 1800 w. Power—March, 1903. No. 53882 C.

Pumping Plant.

A Riedler Pumping Plant for Hydraulic Mining in Alaska. An illustrated account of the Wild Goose Mining and Trading Co.'s plant at Nome. 1400 w. Eng & Min Jour—March 7, 1903. No. 54056.

Pumps.

Hydraulic Experiments on a Plunger Pump. Prof. John Goodman. Describes a series of experiments made on a small plunger pump, for the purpose of solving some of its mysterious actions, and gives results obtained. Ill. 8500 w. Inst of Mech Engrs—Feb. 20, 1903. No. 53927 D.

The Development of High-Pressure Centrifugal Pumps. John Richards. Explains the extensive use of these pumps on the Pacific Coast, their evolution and efficiency. Ill. 1200 w. Min & Sci Pr—Feb. 21, 1903. No. 53892.

Turbines.

Some Recent Water Turbine Plants. A. Steiger. Read at meeting of the Civ & Mech. Engrs. Soc. An illustrated paper on "Recent Turbine Plants in Great Britain and Abroad." Calls attention to the change in water power installations since the advent of electricity, and describes characteristic features of existing plants. 3000 w. Mech Engr—March 14, 1903. Serial. 1st part. No. 54184 A.

See also Electrical Engineering, Generating Stations.

MACHINE WORKS & FOUNDRIES.

Castings.

Casting Commutator Segments. C. Vickers. Directions and suggestions for securing the extreme accuracy required in such castings. Ill. 1800 w. Am Mach—March 5, 1903. No. 53973.

Cost Keeping.

See Industrial Economy.

Drilling.

Experiments upon the Work of Machine Tools—Drilling (Expériences sur le Travail des Machines-Outils—Forage). M. Codron. A study of the power required for various forms of drills, their efficiency and operation, forming a continuation of the author's investigations on machine tools. 12000 w. Bull Soc d'Encour—Jan. 31, 1903. No. 54253 G.

Multiple-Drilling Machines. Illustrations, with brief description of electrically driven machines for bridge work. 600 w. Engng—March 13, 1903. No. 54192 A.

Electric Driving.

See Electrical Engineering, Power Applications.

Files.

The Relative Economy of New and Re-Cut Files. Notes reproduced from a pamphlet issued by the Fairbanks Co., which seem to express the case very fairly. 1000 w. Mech Engr—53995 A.

Foundry.

The Future of the Foundry Industry. Dr. Richard Moldenke. A discussion of the outlook and the labor questions involved. 2800 w. Jour Am Found Assn—March, 1903. No. 53926.

Foundry Management.

Foundry Management in the New Century. Robert Buchanan. Mr. Buchanan's fifth paper discusses especially the cupola, and the conditions involved in its successful and economical use. 4500 w. Engineering Magazine—April, 1903. No. 54-285 B.

Gating.

The Gating of Castings. Benjamin D. Fuller. Read before the Pittsburg Foundrymen's Assn. Illustrated discussion of a number of examples and the methods employed. 2000 w. Foundry—March, 1903. No. 53944.

Grinding.

Cock Grinding Machine. W. E. Willis. Illustrates and describes a four-spindle cock grinding machine and its operation. 1000 w. Am Mach—March 26, 1903. No. 54355.

Index Grinding a Hard Steel Ratchet. Walter Gribben. Illustrates and describes the manner of doing the work. 1200 w. Am Mach—Feb. 26, 1903. No. 53847.

Labor Management.

See Industrial Economy.

Lathe.

Heavy Turret Lathe. Half-tones and line engravings of a new heavy turret lathe, with description of its interesting features. 2000 w. Am Mach—Feb. 26, 1903. No. 53846.

Machine Tools.

Constant Speed Belt-Drive for Machine Tools—Milling Machine Feeds. Herman Isler. An illustrated description of an arrangement of a constant speed belt drive with a table giving the different speeds obtained. 1200 w. Am Mach—March 19, 1903. No. 54144.

Medium and Light Machine Tools (Mittelgrosse und Leichtere Werkzeugmaschinen). H. Unger. An illustrated description of the light lathes, planers, shaping machines, etc., shown at the Düsseldorf exposition, 1902. Serial, Part I. 3000 w. Glasers Annalen—Feb. 15, 1903. No. 54223 D.

See also Mechanical Engineering, Automobiles.

Metal Cutting.

Metal Cutting with the New Tool Steels. Oberlin Smith. Discussing the influence of the introduction of high-speed tool steels upon machine tool design, involving the necessity of heavier construction and higher powering. 3000 w. Engineering Magazine—April, 1903. No. 54287 B.

Moulding.

Molding Air Chambers without Using Chaplets. J. Temple MacCartney. Illustrates and describes the method followed at the foundry of the Scranton Steam Pump Co. 1000 w. Foundry—March, 1903. No. 53945.

Planing.

Some Points About a Planer Shop. Discusses accurate planing, alignment of uprights, keeping planers leveled, gear testing, etc. Ill. 1800 w. Am Mach—March 5, 1903. No. 53972.

Railway Shops.

See Railway Engineering, Permanent Way and Buildings.

Riveting Machines.

Notes on the Design of Riveter Yokes. Chester B. Albree. Discusses the design of a pneumatic toggle joint riveter of 12-foot gap, made in one steel casting, of sufficient stiffness to drive rivets 1¾ inches in diameter. Ill. 2300 w. Pro Engrs of Soc of W Penn—Jan., 1903. No. 54154 D.

Steel Plant.

Steel Castings. George S. Willits. Describes an ideal plant, methods of manufacture, cleaning and testing, etc. 6200 w. Jour Am Soc of Nav Engrs—Feb., 1903. No. 54171 H.

Thermit.

The Thermit Process. Frank C. Perkins. Illustrates and describes the process of repairing castings and welding with thermit, giving an account of a recent demonstration in Brooklyn, and of marine repairs abroad, etc. 3500 w. Mach, N Y—March, 1903. No. 53989.

Works.

Queen's Engineering Works, Bedford. Detailed description, with illustrations of the works of W. H. Allen, Son & Co., builders of marine auxiliary machinery, and power-plant equipment. 2700 w. Engng—Feb. 27, 1903. Serial. 1st part. No. 54013 A.

The Laying Out of Engineers' Workshops. Joseph Horner. The first of a series of articles concerning the conditions which should govern the arrangements, dealing with extensions of old works, laying out of new, etc. 3000 w. Page's Mag—March, 1903. Serial. 1st part. No. 54376 B.

MATERIALS OF CONSTRUCTION.

Abrasives.

Crushed Steel and Steel Emery. M. M. Kann. An account of an artificial abrasive produced from steel, and the uses to which it is applied. 2000 w. Sci Am Sup—March 14, 1903. No. 54088.

Alloys.

Alloys as Revealed by Modern Research. Percy Longmuir. Discusses the tendency of present experiment and research and some of the causes affecting the properties. Ill. 3000 w. Feilden's Mag—March, 1903. No. 54371 B.

Alloys. Warner B. Bayley. Remarks on the increased consumption, improvement in manufacture, etc., with description of methods employed in their manufacture and in the making of tubing. 4200 w. Jour Am Soc of Nav Engrs—Feb., 1903. No. 54173 H.

Brass-Founding. A letter giving general information on alloys of copper. 1500 w. Am Mach—March 12, 1903. No. 54074.

Aluminum.

Aluminography. Translated from the German of Weilandt, in *Der Stein der Weisen*. Describes its use as a substitute for lithographic stone, and the production of printable designs. 5500 w. Sci Am Sup—March 7, 1903. No. 53969.

Working Aluminum. Joseph V. Woodworth. Suggestions for the proper working of this metal. Ill. 2200 w. Am Mach—March 26, 1903. No. 54354.

Brittleness.

See Mining and Metallurgy, Iron and Steel.

Lubricants.

Lubrication. William M. Davis. States the requirements of a good lubricant, and considers essential points in lubrication. 1500 w. Power—March, 1903. No. 53-887 C.

Nickel Steel.

Temporary and Permanent Changes in Nickel Steels (Changements passagers et Permanents des Aciers au Nickel). C. E. Guillaume. A report upon the behaviour of bars of nickel steel under observation for six years, with respect to their suitability for standards of length. 1200 w. Comptes Rendus—Feb. 9, 1903. No. 54-210 D.

White Iron.

Strength of White Iron Castings as Influenced by Heat Treatment. A. E. Outerbridge, Jr. Read at meeting of the Am. Soc. of the International Assn. for Test. Materials. Describes an unusual change observed in the chilled or white iron forming the "treads" of a number of wheels, and the cause; discusses the converting of white castings into "steel;" the differences found in white castings; and gives a resumé of experimental work in this field. 4000 w. Foundry—March, 1903. No. 53946.

MEASUREMENT.

Buckling.

The General Character of the Euler Law of Buckling (Die Verallgemeinerung der Eulerschen Knicklast). F. Wittenbauer. A mathematical examination of Euler's law for the buckling of columns, showing its generality. 2500 w. Zeitschr d Ver Deutschr Ing—Feb. 14, 1903. No. 54215 D.

Calorimetry.

Calorimetry of Gaseous and Liquid Fuels. W. Garnet Wernham. Extracts from a paper read before the Jr. Inst. of Engrs. Considers modern calorimeters, and methods of determining heating values of fuels. 3400 w. Jour Gas Lgt—March 3, 1903. No. 54046 A.

Dynamometer.

A Dynamometer Brake Permitting the Obtaining of a Constant Moment. Ed. Noaillon. Translated from *Bul. Sci. de l'Univ de Liége.* Presents an arrangement claiming that it permits a moment of resistance to act, which is strictly constant, whatever may be the variations in speed. Critical note by editor. 700 w. Sib Jour of Engng—March, 1903. No. 54152 C.

See Railway Engineering, Permanent Way.

Indicators.

Extended Applications for Indicators (Vorschläge über die Weitere Ausbildung von Indikatoren). A. Wagener. Discussing especially the use of the indicator with gas and other internal-combustion engines, and the special devices for such work. 3500 w. Zeitschr d Ver Deutscher Ing—March 7, 1903. No. 54218 D.

The Determination of the Scale of Indicator Springs (Beitrag zur Bestimmung der Massstäbe von Indikatorfedern). E. Förster. Illustrating and describing an apparatus for calibrating springs by steam and by direct loading. 2000 w. Zeitschr d Ver Deutscher Ing—Feb. 28, 1903. No. 54217 D.

Oil Testing.

A New Oil Testing Apparatus (Ein Neuer Oelprüfapparat). G. Dettmar. A revolving spindle carrying sheaves is driven to a certain speed and released, and the time elapsing when it comes to rest is taken as a measure of the value of the lubricant. 1200 w. Glasers Annalen—March 1, 1903. No. 54225 D.

Metric System.

The Metric System. C. H. Tutton. Paper on the proposed measure to make the metric system the only legal standard of the United States, unfavorable to its adoption. General discussion. 5000 w. Jour Assn of Engng Socs—Feb., 1903. No. 54395 C.

Discussion on the Metric System. Abstract of notes by Alexander Siemens in opening the discussion, and Sir Frederick Bramwell's reply. Before the Inst. of Elec. Engrs. (England). 5000 w. Elect'n, Lond—Feb. 20, 1903. No. 53865 A.

Slide Rule.

The Execution of Computations with the Slide Rule (Berekeningen Uitvoerbaar met de Rekenlinaal). F. J. Vaes. Giving numerous examples of the ease and accuracy with which problems of actual importance may be solved by the slide rule. 3500 w. De Ingenieur—Feb. 14, 1903. No. 54267 D.

Speed Indicator.

See Electrical Engineering, Measurement.

POWER AND TRANSMISSION.

Compressed Air.

A Study in the Economical Arrangement of Compressed Air Haulage. Ernest Brackett. Considers the influence of haulage on the economical working limit and on the cross and haulage entry distances. 5600 w. Eng & Min Jour—Feb. 28, 1903. No. 53914.

High Speed Air Compressors (Ueber Kompressoren mit Erhöhten Umdrehzahlen). F. Harth. An examination of the action of air compressors operated at high rotative speeds, with especial reference to valve action and inertia forces. 3500 w. 1 plate. Glückauf—Feb. 14, 1903. No. 54230 D.

The Pneumatic Tube System of a Modern Department Store. Day Allen Willey. Illustrates and describes interesting features of this system. 2000 w. Sci Am—March 21, 1903. No. 54163.

Cone Pulleys.

A Method of Calculating the Range of Speed to be Obtained from a Pair of Equal Cones. Frank B. Kleinhans. Demonstration of the problem. 600 w. Eng News—March 26, 1903. No. 54360.

Laying Out Cone Pulleys. H. F. Moore. Describes method, giving diagrams and tests. 1200 w. Am Mach—Feb. 26, 1903. No. 53848.

Efficiency.

The Efficiency of Mechanism. C. F. Blake. The first of two articles dealing especially with hoisting machinery, discussing the general principles. 2400 w. Mach, N Y—March, 1903. Serial. 1st part. No. 53991.

Rope Splicing.

Transmission Rope Splicing. Frederick S. Greene. An illustrated description of the English transmission splice. 1000 w. Power—March, 1903. No. 53885 C.

Worm Gearing.

Test of a Triple-Thread Worm Gear Transmission (Untersuchung eines Dreigängigen schneckengetriebes). C. Bach & E. Roser. Data and results of tests made at the Stuttgart Polytechnic, with especial reference to the lubrication and temperature. 4000 w. Zeitschr d Ver Deutscher Ing—Feb. 14, 1903. No. 54214 D.

The Construction of a Worm Profile (Konstruktion der Profillote einer Schnecke). H. von Glinski. A brief geometrical discussion of the problem. 1000 w. Zeitschr d Ver Deutscher Ing—March 7, 1903. No. 54219 D.

SPECIAL MOTORS.

Alcohol.

The Potato as a Source of Wealth in Germany. Information relating to the culture and uses, especially as a producer of alcohol. Describes the proposed exhibits at this year's exposition at Berlin, showing the manufacture and many uses of alcohol for technical and industrial purposes. Ill. 3000 w. U S Cons Repts, No. 1599—March 20, 1903. No. 54176 D.

Gas Engines.

A New Double-Acting Tandem Gas Engine. Illustration, with description, of a 1500 horse-power internal combustion engine developed by the Westinghouse Co. 700 w. R R Gaz—Feb. 27, 1903. No. 53-859.

Central Station Gas Engines. C. H. Williams. Read before the Wisconsin Gas Assn. An account of the plant at Madison, Wis., where gas engines have been installed to furnish the motive power of a central station generating plant, with a general discussion of gas engines. 5000 w. Pro Age —Feb. 16, 1903. No. 54069.

Gas and Gasoline Engines. Edward Brenton Boggs. Describes these engines and their cycle of operations, testifying as to their economy and efficiency. 2500 w. Can Engr—March, 1903. No. 53982.

Gas-Engine Valve Gears. Charles Hurst. The discussion is confined to the mushroom type of valve, considering the sizes of the valves and area of passages, position, governing, etc. Ill. 4000 w. Feilden's Mag—March, 1903. No. 54372 B.

Recent Improvements in Gas Engines. Abstract of a paper by James Atkinson, read at meeting of the Manchester Assn. of Engrs. (England), and of the discussion. Calls attention to recent improvements and the rapid development of gas engines. 6000 w. Jour Gas Lgt—March 3, 1903. No. 54045 A.

The Economy of Small Gas Engines Using Montreal Illuminating Gas. Horner M. Jaquays. Information based on tests made under conditions as nearly similar to those which occur in practice as it is possible to make them. Ill. 3000 w. Can Soc of Civ Engrs, Adv Proof—March, 1903. No. 54139 D.

The Letombe Mono-Triplex Gas Engine (Moteur Letombe Mono-Triplex). Illustrated description of the improved two-cycle gas engine of the Letombe pattern for use with furnace gas. 2000 w. Revue Industrielle—Feb. 21, 1903. No. 54276 D.

Gasoline Engines.

The Theory of Operation of the Gasoline Engine. E. C. Oliver. Explains the principles of operation of a two-cycle engine comparing the four-cycle engine, and reports a series of tests made. 4800 w. Jour Assn of Engng Socs—Feb., 1903. No. 54394 C.

See also Mechanical Engineering, Automobiles.

Gas Power.

The Gas Power Plant of the Embrach Potteries (Die Kraftgasanlage der Tonwarenfabrik Embrach). Describing a complete power plant with fuel gas generators, engines of 100 h. p. and electric generators in operation at Embrach, Switzerland. Two articles, 1 plate. 4000 w. Schweiz Bauzeitung—Feb. 28, March 7, 1903. No. 54229 each B.

STEAM ENGINEERING.

Blowing Engines.

The Compounding of Two Simple Blowing Engines. John H. Barr. An account of the scheme for converting two simple blowing engines of different make into a connected compound engine with duplex air cylinders. 1000 w. Sib Jour of Engng —March, 1903. No. 54150 C.

Boiler Coverings.

Tests of Various Methods of Covering Locomotive Boilers (Essais de Divers Modes d'Enveloppes de Chaudières de Locomotives). H. Ledoux. Data and results of tests made upon various laggings for locomotive boilers by the Paris, Lyons and Mediterranean Railway. 3000 w. Rev Gen des Chem de Fer—Feb., 1903. No. 54257 H.

Boiler Explosion.

The Bilston Boiler Explosion. An account of the explosion at the Bradley Bridge Iron Works, and the evidence brought out at the coroner's inquest. 3000 w. Engng—March 13, 1903. No. 54191 A.

Boiler Furnaces.

Corrugated Furnaces. W. C. Eaton. Description and report of tests made of

Brown's improved type. Ill. 3500 w. Jour Am Soc of Nav E ngrs—Feb., 1903. No. 54172 H.

Boiler House.

An Interesting Boiler House at Apponaug, R. I. Illustrated detailed description of the Dunnell boiler house, which serves a bleachery works. 1200 w. Eng Rec—March 7, 1903. No. 54050.

Boilers.

Actual Performance of Babcock and Wilcox Boilers as Installed in U. S. S. Marietta, with General Observations on Practical Requirements and the Successful Operation of Marine Water Tube Boilers. Henry C. Dinger. A detailed report of performance, advantages, defects, improvements, etc., with discussion of marine boiler design. Ill. 8400 w. Jour Am Soc of Nav Engrs—Feb., 1903. No. 54168 H.

Boiler Construction. O. P. Hood. Digest of an address before the Copper Country Engng. Soc. on a neglected principle in boiler design. 1700 w. Aust Min Stand—Jan. 22, 1903. Serial. 1st part. No. 53996 B.

Iron Furnace Boilers. William H. Fowler. Illustrations, with brief descriptions of various types. 1200 w. Mech Engr—Feb. 28, 1903. No. 53994 A.

Multitubular Marine Boilers and Their Features. William H. Fowler. An illustrated description of the "Scotch" type, with discussion of its working. 1200 w. Mech Engr—March 14, 1903. No. 54183 A.

The Naval Boiler Problem. John Halligan, Jr. Discusses its importance in determining naval strength, its endurance under forced draft conditions, giving an illustrated description and an extended series of tests of the Hohenstein boiler. 6800 w. Jour Am Soc of Nav Engrs—Feb., 1903. No. 54174 H.

Chimney.

High Concrete Chimney for the Pacific Electric Ry. Illustrated description of a chimney at Los Angeles, Cal., 180 ft. high, built of armored concrete. 1600 w. Ry & Engng Rev—March 14, 1903. No. 54117.

Condensers.

Central Condensation (Les Condensations Centrales). A. Abraham. A description of the advantages of central condensation and of the various forms of condensers in use in that connection. Serial. Part I. 1200 w. Revue Technique—Feb. 25, 1903. No. 54209 D.

Economy.

Economy in the Use of Coal for the Production of Power. Prof. Ira N. Hollis. Discusses this subject, showing what engineers are trying to accomplish, and the elements of efficiency. General discussion. 6000 w. Jour N Eng W-Wks Assn—March, 1903. No. 54387 F.

Practical Economy in the Power Plant. W. H. Booth. Discussing the importance of taking all factors into account in the maintenance of economy in a power plant, instead of concentrating attention upon the more conspicuous portions. 2500 w. Eng Mag—April, 1903. No. 54282 B.

Engine Foundations.

Steam Engine Foundations. Some points on foundations of brick, stone, and concrete. Ill. 1500 w. Power—March, 1903. No. 53886 C.

Entropy.

Entropy. A review of the controversy of Swinburne v. Perry; Lodge intervening. 3000 w. Fielden's Mag—March, 1903. No. 54373 B.

Entropy. Prof. Robert H. Smith. An explanation of what is meant by the term, and of the causes that have led to misconception. 3200 w. Elec Rev, Lond—March 6, 1903. No. 54101 A.

Rankine's Thermodynamic Function and Entropy. Quotes from Rankine's works concerning the thermodynamic function and its use, and sums the various views upon entropy. 1400 w. Engr, Lond—Feb. 27, 1903. No. 54015 A.

Feed Water.

See Railway Engng., Motive Power.

Firebox.

See Railway Engng., Motive Power.

Mechanical Stokers.

Some Recent Tests of Mechanical Stokers. G. A. Hutchinson. A report of tests made on two representative types. 1200 w. Eng News—March 26, 1903. No. 54362.

The Evolution of the Mechanical Stoker. A. A. Cary. From a discussion at meeting of the New England Cotton Mfgrs. Assn. Gives illustrated description of methods of firing, and of various patents for improving the system, the furnaces, their operation, etc. 6000 w. Power—March, 1903. No. 53883 C.

Oil Fuel.

Liquid Fuel. H. F. Schmidt. A discussion of the advantages, apparatus used, cost, etc., showing that a special study must be made of each plant and the conditions under which it is to operate. 2500 w. Am Elect'n—March, 1903. No. 54030.

Liquid Fuel. W. D. Hoffman. An illustrated article discussing the advantages and obstacles to the use of liquid fuel for locomotive and marine boilers; the fire box, burners, etc. 8200 w. Jour Am Soc of Nav Engrs—Feb., 1903. No. 54175 H.

The Navy Experiments on Oil Fuel. Results and conclusions reached by the Bureau of Steam Engineering with illustrations. 2500 w. Locomotive—Jan., 1903. No. 54337.

Oiling System.

Oiling System for Power Plants. P. E. Moock. Read at meeting of the Ohio Soc. of Mech., Elec., and Steam Engrs. Considers the essentials of a good oiling system, giving suggestions. Ill. 1400 w. Engr, U S A—March 16, 1903. No. 54120.

Reducing Valve.

Royle's Reducing Valve. Illustrated description of a novel design of combined reducing valve and safety valve. 700 w. Mech Engr—Feb. 28, 1903. No. 53993 A.

Safety Valve.

Safety Valves. H. K. Spencer. Considers the method of determining the size of safety valve necessary for a given boiler. 1500 w. Marine Engng—March, 1903. No. 53987 C.

Steam Engines.

Tests of a Steam Engine. Abstract of a report by Prof. Schröter, of Munich, in regard to a series of interesting trials made by him on a Van den Kerchove engine exactly similar in construction to the one they exhibited at Paris, in 1900. 1200 w. Engr, Lond—Feb. 20. 1903. No. 53877 A.

The Investigation of the Stresses on Frames of Vertical, Inverted Steam Engines. G. Schwarz. Translated from the *Zeitschrift des Vereines Deutscher Ingenieure*. Mathematical demonstration. 2200 w. Jour Am Soc of Nav Engrs—Feb., 1903. No. 54166 H.

The Construction of American Marine Engines (Die Konstruktion des Amerikanischen Schiffsmachinen). Walter Mentz. Notes of a journey of inspection, with illustrations of engines of American cruisers and other vessels. Serial. Part 1. 3000 w. 3 plates. Schiffbau—March 8, 1903. No. 54265 D.

Steam Turbines.

Steam Turbines to Date. R. H. Thurston. Abstract of a lecture before the N. Y. Elec. Soc. Brief review of the history of the steam turbine, with remarks on the present status and the trend of progress. 1800 w. Ir Age—March 26. 1903. No. 54336.

The Steam Turbine in a Modest but Useful Aspect. J. E. Johnson, Jr. Illustrates and describes an installation for driving a forge for tool-sharpening. 1400 w. Am Mach—March 5, 1903. No. 53971.

Superheating.

The Use of Highly Superheated Steam. Prof. Ewing. A discussion of some points in regard to the advantages gained by superheating, referring to trials of an engine recently made by the writer. 2000 w. Engr, Lond—Feb. 20, 1903. No. 53876 A.

See Railway Engng., Motive Power.

Valve Gear.

Valve Gear of the Buckeye Engine. Illustrated detailed description. 1800 w. Power—March, 1903. No. 53884 C.

Waste Heat.

Waste Heat Engines. Prof. Edward F. Miller. Discusses recent attempts to increase the efficiency of an engine by reducing the temperature of the exhaust heat, describing the invention of Prof. E. Josse and the working of the engine. 2000 w. Jour N Eng W-Wks Assn—March, 1903. No. 54388 F.

MISCELLANY.

Aeronautics.

Electricity as a Motive Power in Mechanical Flight. Dr. T. Byard Collins. Discusses progress in aerial navigation and the advantages and disadvantages of electricity as a motive power. Ill. 2500 w. Elec Wld & Engr—March 14, 1903. No. 54121.

Safety in Dirigible Balloons (La Securité dans les Ballons Dirigeables). Comm. P. Renard. An examination of recent disasters with dirigible balloons, showing their causes, and discussing necessary precautions. 6000 w. Bull Soc d'Encour—Feb. 28, 1903. No. 54255 G.

The Action of a Bird's Wing and Its Bearing on the Problem of Mechanical Flight. Dr. T. Byard Collins. An illustrated article describing methods of obtaining records of the action, and what they seem to indicate. 1800 w. Sci Am—March 7, 1903. No. 53967.

Air Resistance.

Experiments Upon Air Resistance (Expériences Relatives à la Résistance Opposée par l'Air). M. Barbel. The full report of the Committee of the Society for the Encouragement of National Industry upon the important experiments of Canovetti. 10,000 w. Bull Soc d'Encour—Feb. 28, 1903. No. 54254 G.

Explosives.

The Petavel-Kingsmill Recording Pressure Gauge. Illustrated description of an instrument for measuring the pressures produced by various explosives. 2700 w. Engng—March 13, 1903. No. 54194 A.

Heating.

Hot-Water Heating Systems (Die Einrichtungen zum Erwärmen von Wasser). Otto Marr. Describing various hot water systems, with formulas for use in computation of dimensions. 3000 w. Gesundheits-Ingenieur—Feb. 20, 1903. No. 54262 B.

Temperature Regulation. J. H. Kinealy. Read at meeting of Am. Soc. of Heat. & Ven. Engrs. A discussion of the systems and methods in use. 5500 w. Dom Engng —March 25, 1903. No. 54353 C.

Ventilation and Heating in the East High School, Rochester N. Y. Illustrated detailed description of arrangements for heating and ventilating a school-building having three stories and basement and attic. Mainly a plenum system. 4000 w. Eng Rec—Feb. 28, 1903. Serial. 1st part. No. 53904.

Ordnance.

The Hotchkiss Ordnance Company, Limited. Begins an illustrated description of recent types of rapid-fire machine guns made at these works near Paris. 4500 w. Engng—Feb. 20, 1903. Serial. 1st part. No. 53879 A.

MINING AND METALLURGY

COAL AND COKE.

Anthracite.

Compressive Strength of Anthracite Coal. Tabulated results of investigations made by a committee of the Scranton Engrs. Club. 1500 w. Mines & Min—March, 1903. No. 53979 C.

Coal-Cutting.

Notes on Coal-Cutting by Machinery. Abstract of a paper by A. Dury Mitten, and the discussion. Shows that the conditions of the present make the subject an important one, and discusses briefly the advantages and difficulties. 2000 w. Col Guard—Feb. 20, 1903. No. 53875 A.

Coal Strike.

See Industrial Economy.

Coke.

The Demand for Coke. Frederick E. Saward. Gives facts in regard to the production and discusses its possible increase. 1300 w. Ir Age—March 12, 1903. No. 54021.

Coke Plant.

The New Coking Plant at the Theresa Mine in Polnisch-Ostrau (Die Neue Cokeanstalt am Theresienschachte in Polnisch-Ostrau). Dr. A. Fillunger. A description of important by-product coking works in Northern Austria. The gases are used for motive power. Two articles, 2 plates. 3000 w. Oesterr Zeitschr f Berg u Hüttenwesen —Feb. 28, March 7, 1903. No. 54233 each D.

Collieries.

The Mechanical Engineering of Modern Collieries. William Bardill. Abstract of a paper read before the Birmingham Sec. of the Inst. of Mech Engrs. Brief consideration of the mechanical appliances the mining engineer has found necessary in carrying on his work. 3000 w. Col Guard—March 20, 1903. No. 54401 A.

Germany.

The Costs and the Conditions of Working Collieries in Germany. The present article gives information concerning the Harpen collieries, their production, earnings, expenses, profits, etc. 1700 w. Ir & Coal Trds Rev—March 6, 1903. Serial. 1st part. No. 54109 A.

Lignite.

The Lignite Mines of North Dakota. Frank N. Wilder. Facts relating to output, the development of the lignite industry, mines and methods of mining. 2000 w. Eng & Min Jour—Feb. 28, 1903. No. 53912.

Mining Industry.

The Coal Mining Industry of the South. Frederick E. Saward. Reviews the rapid development of recent years in Alabama, West Virginia, Virginia, Kentucky, Tennessee, Indian Territory, Maryland and Texas. 2000 w. Ir Age—March 5, 1905. No. 53906.

Pennsylvania.

Lower Productive Coal Measures of the Bituminous Regions of Pennsylvania. Thomas K. Adams. Read before the W. Penn. Cent. Min. Inst. Describes the characteristic features of these deposits. 5800 w. Mines & Min—March, 1903. No. 53-976 C.

United Kingdom.

Rise and Progress of Coal-Mining in the United Kingdom. Prof. R. A. S. Redmayne. Notes of the first of a series of lectures delivered at the University of Birmingham. The present article reviews the early history. 2500 w. Col Guard—March 6, 1903. No. 54106 A.

Waste.

Squandering Coal. Egbert P. Watson. Remarks on the wastefulness so general in the United States, illustrating by actual occurrences, and urging greater economy. 1600 w. Ir Age—March 26, 1903. No. 54334.

COPPER.

Analysis.

The Estimation of Copper in Ores, Mattes, etc. O. H. Packer. Considers methods for the quantitative analysis of copper ores and products, especially commending and describing the aluminum strip, cyanide method. 2500 w. Elec Rev, N. Y.—March 14, 1903. No. 54077.

Arizona.

The Copper Deposits of Bisbee, Arizona. F. L. Ransome. A preliminary outline published by permission of the Director of the U. S. Geol. Survey. Considers the early history, geological features, character of ores, their origin, etc. Ill. 2200 w. Eng & Min Jour—March 21, 1903. No. 54330.

Blast Furnaces.

Width of Furnace Relative to Tonnage in Copper Matte Blast Furnace Practice. W. Randolph Van Liew. Reports results of a five days' trial and compares with other reports relating to furnaces of different widths, favoring the narrower furnace. 2200 w. Eng & Min Jour—March 21, 1903. No. 54329.

Copper Trade.

See Industrial Economy.

Michigan.

Copper Mining in Upper Michigan. J. F. Jackson. An illustrated description of the methods of opening and working the mines; with general discussion. 7000 w. Jour W Soc of Engrs—Feb., 1903. No. 54147 D.

Refining.

Progress in the Electrolytic Refining of Copper in 1902. Titus Ulke. A review, giving tables showing the electrolytic copper refineries operated during the year in the United States and in Europe. 2000 w. Eng & Min Jour—March 14, 1903. No. 54082.

GOLD AND SILVER.

Brazil.

The Gold Fields of Calcoeñe, Brazil. Maurice Cleré. Gives location, occurrence, deposits, etc. Ill. 1000 w. Eng & Min Jour—Feb. 28, 1903. No. 53913.

Cyaniding.

Cyanidation at the Homestake Mine. C. W. Merrill. Abstract of a paper read before the Black Hills Mining Men's Assn. Considers the nature of the ore, milling, classification, treatment, precipitation, etc. 3500 w. Eng & Min Jour—March 7, 1903. No. 54055.

Cyaniding Wet Crushed Ores. Hamilton Wingate. Describes experiments made with lime in the treatment of slimes, and the general treatment of refractory ores. 1400 w. Aust Min Stand—Feb. 12, 1903. Serial. 1st part. No. 54332 B.

East Indies.

Gold Mining in the Dutch East Indies. Map, with outline of the progress in mining. 2300 w. Eng & Min Jour—March 7, 1903. No. 54053.

Geological Survey.

West Coast of Cape York Peninsula, and Horn Island and Possession Island Goldfields. C. F. V. Jackson. Report of a visit, with twelve illustrations and maps. 11700 w. Queensland Gov Min Jour—Jan. 15, 1903. No. 53957 B.

Gold-Dredging.

The Development of Gold-Dredging in the United States. Ralph L. Montague, in London *Mining Journal*. Describes the type of dredge used, stating its advantages, and comparing with the New Zealand type; also gives brief history of the undertakings in the United States. 3000 w. Can Min Rev—Feb. 28, 1903. No. 53911 B.

Hydraulic Mining.

See Mechanical Engng., Hydraulics.

Mexico.

Minas Nuevas, Parral, Mexico. G. A. Burr and Louis S. Cates. Gives a plan showing the mines of the Veta Colorado, and begins a detailed report of their working and output. Mainly producers of silver. 2000 w. Eng & Min Jour—March 14, 1903. Serial. 1st part. No. 54081.

Nome.

Boring the Tundra of the Nome Gold Fields in Search of Gold. Otto Halla. Gives an account of investigations which have shown that the deposits between the hillsides and the Behring sea contain large amounts of auriferous gravel. 1000 w. Min Sci Pr—Feb. 28, 1903. No. 54025.

Ontario.

Notes on the Gold Ores of Western Ontario. Charles Brent. Describes the geology of these fields and the deposits, the interesting features, associated minerals, etc. 4000 w. Can Min Rev—Feb. 28, 1903. No. 53910 B.

Refining.

See Electrical Engineering, Electrochemistry.

Tailings.

Practical Application of Dr. Black's Permanganate Process. D. F. Meiklejohn. Illustrates the plant at Sierra City, Cal., and gives a report of a practical trial of the process and the results. 1600 w. Min & Sci Pr—Feb. 28, 1903. No. 54026.

IRON AND STEEL.

Bessemer Steel.

Bessemer Steel, Basic and Acid Process, with Analysis and Physical Tests. Robert H. Probert. Read at meeting of Ohio Soc. of Mech., Elec., and Steam Engrs. Discusses the manufacture of Bessemer steel. 4000 w. Engr, U S A—March 16, 1903. No. 54119.

Brittleness.

Experimental Studies of the Causes of Brittleness of Steel. Ch. Fremont. An illustrated description of experiments which show that both tension and compression tests are necessary and that flexure is a complete method of testing on condition that one gives to it the proper sensitiveness. 2800 w. R R Gaz—March 13, 1903. No. 54131.

Electric Smelting.

See Electrical Engineering, Electro-Chemistry.

Ferromanganese.

A Study of Ferromanganese (Zur Kenntnis des Technischen Ferromangans). Th. Naske & A. Westermann. Discussing chemical analyses of commercial specimens of ferromanganese, showing the manner in which the constituents are combined. 3000 w. Stahl u Eisen—Feb. 15, 1903. No. 54247 D.

Fuels.

The Use of High Sulphur Fuels in Blast Furnaces. Oskar Simmersbach, in *Stahl und Eisen.* Abstract translation showing the influence of sulphur on the various ores, and that high-sulphur fuel can be used under certain conditions. 1500 w. Ir Age—March 12, 1903. No. 54024.

Germany.

The Iron and Steel Industries of Germany in 1902. Herr Emile Schrodter. Report of general conditions, prices, exports, etc. 1300 w. Ir & Coal Trds Rev—Feb. 27, 1903. No. 54012 A.

The Present Condition of the Iron and Steel Industries of Westphalia (Etat Actuel des Industries du Fer et de l'Acier dans les Provinces du Rhin et de la Westphalia). A. Gowry. An exhaustive review of the metallurgical industries of Rhenish Prussia, with tables and numerous illustrations. 30,000 w. 5 plates. Mem Soc Ing Civ de France—Jan., 1903. No. 54264 G.

Iron Ore.

Applications of Magnetic Iron Ores Lean in Phosphorus (Verwendung von Phosphorarmen Magneteisensteinen). A discussion of the practicability of using the magnetites of northern Sweden in connection with hematite ores. 2000 w. Stahl u Eisen—Feb. 15, 1903. No. 54246 D.

Iron Trade.

See Industrial Economy.

Open Hearth.

Preliminary Refining in Connection with the Bertrand-Thiel and Thomas Processes (Ein Neues Vorfrischverfahren in seiner Anwendung auf den Bertrand-Thiel und Thomas Prozess). O. Thiel. Showing the advantages of the use of a preliminary furnace or converter in steel making. 2000 w. Stahl u Eisen—March 1, 1903. No. 54248 D.

Steel Plant.

The New Plant of the Jessop Steel Co. at Washington, Pa. H. G. Manning. Brief illustrated description of a plant consisting of a melting shop, rolling mill, power house and pickling shed. 1600 w. Eng News—Feb. 26, 1903. No. 53854.

See Mechanical Engineering, Machine Works and Foundries.

White Iron.

See Mechanical Engineering, Materials.

MINING.

Accounting.

See Industrial Economy.

Boring.

A Dutch Deep Boring Plant (Een Nederlandsche Diepboor Inrichting). C. J. Van-Loon. Illustratng and describing a well boring plant for explorations for coal and petroleum. 1800 w. De Ingenieur—Feb. 14, 1903. No. 54266 D.

Concentration.

The Concentration in Cornwall. C. M. Myrick. Illustrations, with outline of concentrating process used for the tin ores until a few years ago, when the more progressive mines introduced machinery. 1800 w. Min & Sci Pr—March 14, 1903. No. 54312.

Debris.

Impounding Mining Debris in Yuba River, California. Franklin Riffle. An account of the troubles arising from hydraulic mining and the dumping of tailings into the river, and the action taken by the Debris Commission for the storage of the detritus. 2300 w. Eng Rec—Feb. 28, 1903. No. 53903.

Drainage.

Mines Drainage in North Staffordshire. Richard H. Wynne. Notes on the Pottery Coal-field describing its geological and general construction, and some characteristics of its minerals, and methods used in freeing the mines of water. 1600 w. Ir & Coal Trds Rev—Feb. 27, 1903. No. 54011 A.

Electrical Prospecting.

The Daft and Williams System of Electrical Prospecting for Mineral Ores. Brief illustrated description of this system of locating bodies of metallic ore beneath the earth's surface. 900 w. Elec Engr, Lond—Feb. 20, 1903. No. 53867 A.

Electric Power.

See Electrical Engineering, Power Applications.

Electric Pumping.

See Electrical Engineering, Power Applications.

Fires.

Mine Fires. John Herman. Discusses the causes of fire and methods used in overcoming them. 1800 w. Min Rept—March 19, 1903. No. 54314.

Head Frames.

The Head Frames of Shafts at Cripple

Creek. Alexander Forsyth. A discussion of the problem of erecting frames for vertical shafts, stating the requirements and considering them seriatim. Ill. 2400 w. Eng & Min Jour—March 7, 1903. No. 54054.

Mine Disaster.

The Fraterville Mine Disaster. Official report of Hon. R. A. Shifflett, Commissioner of Labor, to the Governor of Tennessee, in regard to the accident. 5300 w. Mines & Min—March, 1903. No. 53978 C.

Mining Building.

The Hearst Memorial Mining Building, University of California. S. B. Christy. Description of this building for the University of California, for the instruction of students in mining and metallurgy. 1800 w. Eng & Min Jour—March 21, 1903. No. 54331.

Mother Lode.

Recent Mining and Milling Costs and Methods on the Northern Lode, California. Frank Langford. Describes methods of working and reports costs. 1500 w. Eng News—March 26, 1903. No. 54364.

Ore Deposits.

Secondary Enrichment of Ore Deposits. Prof. Arthur Lakes. Discusses the causes and effects of secondary deposits, with especial reference to the copper deposits at Cripple Creek and at Butte, giving briefly the conclusions of various authorities. 1200 w. Mines & Min—March, 1903. No. 53975 C.

The Ore Deposits of the Iglesias District, Sardinia. Abstract from a paper by Bergreferendar Duenkel, in *Zeitschrift f. d. Berg. Hutten u. Salinenwesen.* The deposits are chiefly argentiferous galena, but also blende and calamine. 1800 w. Eng & Min Jour—March 14, 1903. No. 54083.

Shaft Sinking.

Cost of Shaft-Sinking and Drifting at the Lincoln Gold Mine, California. Detailed statement of cost, taken from the report of E. C. Voorheis, with some additional facts. 800 w. Eng News—March 19, 1903. No. 54305.

Smelting.

Pyritic Smelting. Franklin R. Carpenter. Condensed from Bul. of Colorado Sch. of Mines. A discussion of the process or processes. 1200 w. Min & Sci Pr—March 14, 1903. Serial. 1st part. No. 54313.

Water Zone.

Water in Veins.—A Theory. T. A. Rickard. Based on information collected during the past two years concerning the manner of occurrence of water in veins. Believes in the existence of a distinct water zone. 3500 w. Eng & Min Jour—March 14, 1903. No. 54080.

MISCELLANY.

Mica.

The Crown Mica Mine, Custer City, South Dakota. Dennis Henault. Describes the peculiar occurrence at this mine, and the method of preparing for market. Ill. 1000 w. Min & Sci Pr—March 21, 1903. No. 54397.

Petroleum.

How Was Petroleum Made? J. Willway Treadwell, in the *Min. & Engng. Rev.* of San Francisco. A justification of the views of Alexander Humboldt against A. S. Cooper. 1500 w. N Z Mines Rec—Jan. 16, 1903. No. 53999 B.

Review.

Recent Progress in the Metallurgical Industries (Die Neuestern Fortschritte auf dem Gebiete der Metallurgie). Dr. Carl Schnabel. A general review of developments in the metallurgy of gold, silver, copper, lead, zinc, and nickel during 1902. 3500 w. Glückauf—Feb. 28, 1903. No. 54231 D.

Tin.

The Greenbushes Tinfield, W. A. C. A. Mulholland. Begins a description of an interesting field from a scientific point of view, from the variety of the deposits and the metallurgical problems to be solved. 1200 w. Aust Min Stand—Jan. 29, 1903. Serial. 1st part. No. 53997 B.

Zinc Oxide.

Ellershausen and Western's Zinc White Process. Edward Walker. Information of a new process of making zinc oxide direct from blende. 900 w. Eng & Min Jour—March 14, 1903. No. 54079.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in January. Condensed record with editorial review of the more serious accidents. 5300 w. R R Gaz—Feb. 27, 1903. No. 53860.

Passenger Service.

Express Passenger Travelling in the Future. H. C. Fyfe. An illustrated discussion of the monorail (Behr) system, and of the suspended railway system as solutions of the problem of conveying passengers at high speed. 4800 w. Page's Mag—March, 1903. No. 54375 B.

Pooling.

Pooling Engines. J. V. N. Cheney. A statement of some of the trials and troubles due to the pooling of engines. 2400 w. R R Gaz—March 6, 1903. No. 54038.

Train Indicator.

An Electric Train Indicator. E. C. Parham. Describes a device whereby passengers at stations may tell the destination of any approaching train. 1200 w. Am Elect'n—March, 1903. No. 54033.

MOTIVE POWER AND EQUIPMENT.

Brakes.

Hill's Either-Side Brake. Illustrates and describes an improvement effected in the working parts of this brake, and also illustrates the Platt brake, the owners having brought suit for infringement. 800 w. Col Guard—Feb. 20, 1903. No. 53873 A.

The Structure and Service of Modern Brakeshoes. F. W. Sargent. Read before the New England Air Brake Club. Considers the action of brake shoes, the effect of heat generated, the various types in general use, wear, etc. 4200 w. Ry Age—Feb. 27, 1903. No. 53890.

Cars.

Large Capacity Gondola Cars; Chicago & Alton Ry. Brief illustrated description. 500 w. Eng News—Feb. 26, 1903. No. 53856.

Pratt Side Dumping Coal Car. Drawings and description of a 60,000-lb. car. 500 w. R R Gaz—Feb. 27, 1903. No. 53858.

Feed Water.

The Chicago & North-Western Railway Company's Method of Purifying Water for Locomotive Boilers. G. M. Davidson. On the treatment to remove scale-forming matter, showing that it can be easily and economically accomplished. Illustrated description of apparatus used, and report of cost, etc. Also discussion. 18500 w. Pro W Ry Club—Feb. 17, 1903. No. 54138 C.

The Purification of Feed Water. J. B. Greer. Read before the Ry Club of Pittsburg. A review of what has been accomplished in the purification of water for boiler use. 2000 w. Ry & Engng Rev—Feb. 28, 1903. No. 53894.

Firebox.

A Water Arch for Locomotive Fireboxes; Montana Central Ry. Illustrated description of the application of water arch to a wide fire box locomotive of the Great Northern Ry., invented by A. E. Taber. Gives results of experience with its use. 700 w. Eng News—March 19, 1903. No. 54310.

Locomotives.

A Proposed Single Driver Locomotive. Paul T. Warner. Gives diagram showing the principal features of a single driver locomotive with single cylinders, designed for burning bituminous coal and capable of hauling 250 tons exclusive of its own weight, at 60 miles an hour. Discusses its efficiency. 900 w. R R Gaz—Feb. 27, 1903. No. 53861.

"Belpaire" Express Locomotive, Midland Railway. Illustrations, with brief description of recently built engines. 600 w. Engr, Lond—March 13, 1903. No. 54197 A.

Compound Coupled Locomotive for the Mediterranean System (Locomotiva Compound a 4 Assi Accoppiati e Carello della Rete Mediterranea). Illustrated description of 70 ton freight engine of which type 30 are under construction for the Mediterranean railway system of Italy. 1200 w. Rivista delle Strade Ferrate—Feb. 15, 1903. No. 54275 D.

English and German Tank Locomotives. Frank C. Perkins. Illustrated descriptions of a British "Saddle Tank" engine, and a similar side tank engine of the "Bengal" class, and of a four-wheel connected tender locomotive of German build. 700 w. Sci Am Sup—Feb. 28, 1903. No. 53844.

Express Passenger Engine. Illustrated detailed description of a powerful type of locomotive for handling very heavy traffic on the London, Chatham, & Southeastern Ry., which abounds in steep inclines and sharp curves. 800 w. Engr, Lond—Feb. 27, 1903. No. 54016 A.

Freight Locomotives. Drawings, photograph and general description of engines of the 2-8-0 type being built for the C., R. I., & P. Ry. 600 w. Am Engr & R R Jour—March, 1903. No. 53925 C.

German Freight and Switching Locomotives. Illustrations, with brief description of two types of freight locomotives and a switching engine, all of recent construction. 700 w. Ry & Engng Rev—Feb. 28, 1903. No. 53895.

Heavy Freight Locomotives for the Chicago, Burlington & Quincy System. Illustrated description of a consolidation freight engine which represents the heaviest class yet built for this line. 1600 w. Ry & Engng Rev—Feb. 28, 1903. No. 53893.

Locomotives and Cars for Express Service (Lokomotiven und Wagen für Schnellverkehr). An examination of the designs awarded prizes at the recent competition of the Verein Deutscher Maschinen Ingenieure. 2500 w. 6 plates. Glasers Annalen—March 1, 1903. No. 54227 D.

Pacific Type Locomotive for Northern Pacific. Illustration, elevations and plan of an engine for heavy fast passenger service in mountain districts, with description. 500 w. Ry Age—Feb. 27, 1903. No. 53889.

Powerful Passenger Locomotive. Illustrated detailed description of engines of the 4-6-2 type, intended for very heavy and comparatively slow passenger excursion trains. 600 w. Am Engr & R R Jour—March, 1903. No. 53921 C.

Six-Coupled Locomotive for Fast Goods Traffic; Great Central Railway. Illustration of a six-wheeled coupled bogie mixed train engine and tender recently constructed for fast goods and fish trains on this road. Leading particulars are given. 500 w. Engng—March 20, 1903. No. 54402 A.

Some Abnormal British Locomotive Types. Charles Rous-Marten. An illustrated article describing peculiar types that have appeared on British railways. 6300 w. Cassier's Mag—March, 1903. No. 54136 B.

Steam Distribution in Compound Locomotives (Les Distributions des Locomotives Compound). R. Godfernaux. Discussing especially the Gölsdorf and the Henschel valve gears for compound locomotives. 2000 w. Rev Gen des Chem de Fer—March, 1903. No. 54261 H.

Ten-Wheeled Engine for the Rutland. Illustration, with brief description. 300 w. Loc Engng—March, 1903. No. 53919 C.

Test of Oil Burning Locomotive. Report of a running test, with full tonnage, made on the A. T. & S. F. Ry. for a distance of 1,422 miles. 600 w. Am Engr & R R Jour—March, 1903. No. 53924 C.

Lubrication.

Simple vs. Compound Lubrication. C. B. Sopper. A comparison of the amount of lubricant required for simple and compound locomotives. 1600 w. Loc Engng—March, 1903. No. 53918 C.

Speed Indicator.

See Electrical Engineering, Measurement.

Superheating.

Locomotive for Superheated Steam (Heissdampflokomotive). J. Obergethmann. An illustrated description of the Schmidt locomotive, exhibited at Düsseldorf and built for the Prussian State Railways. Serial. Part I. 2500 w. 1 plate. Zeitschr Ver Deutscher Ing—Feb. 28, 1903. No. 54216 D.

See Mechanical Engineering, Steam Engineering.

Tank Car.

The Van Dyke Tank Car. Illustrates and describes a new tank car of simple design, calling attention to novel features. 800 w. R R Gaz—March 6, 1903. No. 54037.

Train Lighting.

Electric Lighting of Trains. An illustrated description of the Kull system. 1300 w. Aust Min Stand—Jan. 29, 1903. Serial. 1st part. No. 53998 B.

Electric Train Lighting (Elektrische Zugsbeleuchtung). Reviewing the methods using a dynamo driven from the car axle, with especial reference to the Stone system. 1800 w. Schweizerische Bauzeitung —Feb. 21, 1903. No. 54228 B.

The Adlake Acetylene Car Lighting System. Louis K. Gillson. Read before the New England Ry. Club. A description of this system, claiming efficiency, economy, reliability, and safety. 4000 w. Ry & Engng Rev—Feb. 28, 1903. No. 53896.

Wheel Loads.

See Civil Engineering, Bridges.

NEW PROJECTS.

Cuba.

Opening of New Railroad in Cuba. J. W. Davies. An illustrated historical account of the road connecting Santa Clara with Santiago de Cuba, thus opening the whole island, and conferring great benefits. 1700 w. Gunton's Mag—March, 1903. No. 53932.

Pennsylvania R. R.

Improvements on the Pennsylvania Railroad. S. Whinery. An outline of some of the more important improvements in progress, as well as those recently completed and projected. Ill. 4800 w. R R Gaz—March 13, 1903. Serial. 1st part. No. 54126.

Railroad Development.

The Kansas City, Mexico & Orient Railway Enterprise, Map and description of new line that will connect at Port Stilwell with steamships for the Orient. 3800 w. Ry Age—March 20, 1903. No. 54346.

PERMANENT WAY AND BUILDINGS.

Accounting.

Classification of Maintenance-of-Way Expenses. Walter G. Berg. Read at convention of Am. Ry. Engng. & Maintenance of Way Assn. On the distribution of railroad expenses, outlining a proposed system for keeping accounts. 16700 w. Ry Age—March 20, 1903. No. 54352.

Automatic Stops.

An Expert's Experience with Automatic Stops. W. H. Elliott. A discussion of the inherent difficulties in the working of the automatic stop that make its use objectionable. 3500 w. R R Gaz—March 6, 1903. No. 54036.

Construction.

Engineering and Construction of the St. Louis, Kansas City & Colorado Railroad. Inset and illustrations with description and general information, specifications, etc. 6800 w. Ry Age—March 20, 1903. No. 54343.

Culverts.

Methods of Surfacing Concrete Culverts. George W. Lee. Illustrates and describes the new culverts on the Pennsylvania Division of the New York Central R. R., and the methods of construction. 700 w. Eng News—March 19, 1903. No. 54304.

Curves.

Method of Computation by the Addition of Ordinates (Procédé de Calcul par Addition d'Ordonnées). Pierre le Fort. Describing a method of equalizing railway curves permitting a continuous variation in the radius of curvature in all cases. 12000 w. Rev Gen des Chem de Fer—March, 1903. No. 54260 H.

Spiral Curves for Railways (Cur les Raccordements à Courbure Progressive pour Voies Ferrées). M. d'Ocagne. A discussion of the clothoide curve, with tables for its application to railways. 4500 w. Ann des Ponts et Chaussées—3 Trimestre, 1902. No. 54251 E+F.

Dynamometer.

Dynamometer Car of the Orleans Railway (Wagon Dynamometre de la Compagnie d'Orleans). M. Huet. Illustrated description of dynamometer car containing improved recording devices constructed by Amsler, of Schaffhausen. 3500 w. 3 plates. Rev Gen des Chem de Fer—March, 1903. No. 54259 H.

Electrical Equipment.

See Electrical Engineering, Power Applications.

Rails.

The Rail as a Girder. Dr. P. H. Dudley. Gives evidence from experience demonstrating the value of stiffness in a rail as a girder and discussing the subject generally. 3500 w. R R Gaz—March 13, 1903. No. 54133.

Relocation.

Relocation of the Chicago, Burlington & Quincy in Western Iowa. An illustrated article, showing changes made to eliminate short radius curves and steep grades. 1300 w. Ry Age—March 20, 1903. No. 54-348.

Roadway.

Specification for the Formation of a Roadway. Part of the committee report on roadway at the convention of the Am. Ry. Engng. & Maintenance of Way Assn. 7500 w. Ry & Engng Rev—March 21, 1903. No. 54321.

Shops.

Extensive Shop Improvements. Plans, illustrations and description of the important features in the extensive improvements under way at Jackson, Mich., for the shops of the Michigan Central Railroad. 3000 w. Am Engr & R R Jour—March, 1903. No. 53922 C.

Railroad Shops. Walter G. Berg. The first of a series of articles discussing carefully the shop question and its relation to the other departments. Ill. 3000 w. R R Gaz—March 13, 1903. Serial. 1st part. No. 54127.

The Reading Locomotive Shops. An illustrated detailed description of one of the most extensive locomotive repair shops in the United States, and the equipment. 4500 w. Ry Age—March 6, 1903. No. 54027.

Signals.

Block Signals on American Railroads. Gives tabulated statement of the miles worked by the block system on each road using it, with notes on proposed new signalling. 2000 w. R R Gaz—Feb. 27, 1903. No. 53857.

Electric Interlocking at the Lake Shore-Rock Island Terminal. Diagram of the yard at Chicago, with brief description. 500 w. R R Gaz—March 13, 1903. No. 54125.

Signalling and Interlocking. Report, with colored inset, presented at convention of the Am. Ry. Engng. & Maintenance of Way Assn. Also discussion. 20,000 w. Ry Age—March 20, 1903. No. 54351.

Train Order Signals. Part of the report of the committee on signaling and interlocking presented at the convention of the Am. Ry. Engng. & Maintenance of Way Assn. 1200 w. Ry & Engng Rev—March 21, 1903. No. 54320.

Station.

The New Rock Island-Lake Shore Passenger Station at Chicago. Illustrated description of a combined office building and station, which is of interest because of the dispatch with which the work has been carried on. 2000 w. Ry Age—March 20, 1903. No. 54344.

Terminal Improvements.

The St. Louis Terminal Improvements. Inset, with description of the rearrangement to enlarge the capacity and improve the facilities. Some interesting engineering problems involved. 3400 w. R R Gaz—March 20, 1903. No. 54318.

Ties.

Ties. From a report of the committee on ties to Am. Ry. Engng. & Maintenance of Way Assn. 2500 w. Ry & Engng Rev—March 21, 1903. No. 54322.

Tracks.

The Effect on Track of Modern Equipment and High Speed. P. H. Dudley. A discussion of the distribution of loads, and of stresses, and of various things bearing on the wearing of tracks. Considers the statements of Mr. Hugh Wilson. 2800 w. Ry Age—March 20, 1903. No. 54342.

Tunnels.

See Civil Engineering, Construction.

Water Supply.

Chicago & Alton Water Supply. An illustrated description of the system of reservoirs, with information relating to them. 1500 w. Ry Age—March 20, 1903. No. 54347.

Yards.

A New Yard Design. W. C. Cushing. Gives a plan of a gravity freight yard for a large traffic, designed by the writer, with remarks on defects observed in the committee design. 1800 w. R R Gaz—March 13, 1903. No. 54132.

TRAFFIC.

Freight.

The Most Advantageous Loads and Speeds for Merchandise Trains (Les Charges et les Vitesses le Plus Favorables des Trains de Marchandises). F. Barbier. Deducing formulas in which to introduce the operative conditions and determine the best train mileage. 1800 w. Génie Civil—Feb. 14, 1903. No. 54201 D.

Report.

Colonel Yorke's Report on American Railroads. Extracts from the report of Col. H. A. Yorke to the British Board of Trade. 2000 w. R R Gaz—March 20, 1903. No. 54319.

American and British Railway Methods. Editorial review of Col. Yorke's report to the British Board of Trade on a visit to the United States made with a view to investigate railway methods. The present article deals with steam railway practice only. 3000 w. Mech Engr—March 14, 1903. No. 54182 A.

Traffic Problems in England and America. R. H. Scotter. An analysis of Col. Yorke's report to the British Board of Trade upon his recent visit to America. 3000 w. Elec Times—March 12, 1903. No. 54181 A.

The Pennsylvania Annual Report. A report of operation for 1902; improvements made and expenditures; and improvements planned; with much information of interest. Also editorial. 6700 w. R R Gaz—March 6, 1903. No. 54039.

Time Element.

The Influence of Time Element on Mechanical and Transportation Matters. H. T. Herr. Discusses the proper basis for traffic statistics, with the view of drawing out opinions of others, and securing economy and efficiency. 1400 w. Am Engr & R R Jour—March, 1903. No. 53920 C.

Train Speed.

The Efficient Speed of Freight Trains (De Gunstige Snelheid van Goederen Treinen). F. J. Vaes. With tables and curves showing the relation between cost and speed in merchandise transport. 3500 w. De Ingenieure—March 7, 1903. No. 54269 D.

MISCELLANY.

Missouri.

Early History of Railroads in Missouri. W. J. Thornton. A general review of railroad development in the United States, and detailed history of the roads in the state named. 6800 w. St. Louis Ry Club —Feb. 13, 1903. No. 53937.

Railway Practice.

Diversity of Practice in General Engineering on American Railways. Archibald A. Schenck. Notes some points of difference in engineering practice on American railways. Deals chiefly with methods of work, showing the leading aim on various roads. General discussion follows. 31000 w. Jour W Soc of Engrs—Feb., 1903. No. 54148 D.

Taxation.

The Wisconsin Railway Taxation Bill. Gives extracts from the briefs presented by the C. M. & St. P. and the C. & N. W. Rys. in reply to the recommendations on railway taxation in Gov. La Follette's annual message. 11600 w. Ry Age—March 13, 1903. No. 54112.

STREET AND ELECTRIC RAILWAYS

Car Houses.

Car House Construction. Discusses design and construction, the need of getting as nearly complete fireproofing as possible, giving examples illustrating points discussed. Ill. 3500 w. St Ry Jour—March 14, 1903. No. 54114 D.

Cars.

New York Subway Cars. Gives plans and general description of the standard construction determined upon, 500 cars now being built. 1000 w. Am Engr & R R Jour—March, 1902. No. 53923 C.

Car Works.

The British Electric Car Company. Illustrated description of the factory and its equipment, and the electric cars built. 2300 w. Engng—Feb. 20, 1903. No. 53878 A.

Chicago.

Modern Shops and Methods of the Chicago City Railway Company. Illustrates and describes shops representing the most modern ideas as to construction and equipment. 3500 w. St Ry Jour—March 7, 1903. No. 54064 D.

Electric Locomotives.

Accumulator Locomotives on Two Lines of the Italian Central Railway in Emilia, Italy. Enrico Bignami. An illustrated account of tests with accumulator traction on the Bologna-San Felice line and the Bologna-Modena. 3000 w. Elec Rev, N Y—Feb. 28, 1903. No. 53897.

Electric Locomotives for Yard and Shop Work. Classifies industrial electric locomotives, and considers some of their important uses. Ill. 1000 w. Sci Am—March 7, 1903. No. 53968.

The Electric Locomotives on the Western Railway of France. Views and particulars of machines possessing very novel features, in use on the Versailles division. 1100 w. St Ry Jour—Feb. 28, 1903. No. 53915 D.

Elevated Structure.

Elevated Structure of the New York Rapid Transit Railroad. Illustrates and describes interesting details of this viaduct. 1100 w. Eng Rec—Feb. 28, 1903. No. 53900.

Engines.

The Choice of Engines for Traction Stations. E. Kilburn Scott. Considers the importance of simplicity of design, and states the advantages of the ordinary tandem—compound single-crank engine and the employment of high superheat. 800 w. Elec Rev, Lond—Feb. 27, 1903. No. 54006 A.

Europe.

Electric Railway Practice on the Continent of Europe. Heinrich Vellguth. An illustrated account of the most interesting developments in electric railway practice in Austria, Hungary and Italy. 3000 w. St Ry Jour—March 7, 1903. No. 54062 D.

Grades.

Units for Indicating Grades. Carl Hering. Refers to sources of confusion, and gives a conversion table for grades. 1000 w. St Ry Jour—March 7, 1903. No. 54063 D.

Guard Wires.

Board of Trade Guard Wire Regulations for Electric Tramways. A copy of the new regulation to be required in all new undertakings in England. 1600 w. Elect'n, Lond—Feb. 20, 1903. No. 53864 A.

Interurban.

A Decade of Interurban Electric Railways. Louis Bell. Reviews the electric interurban development, and discusses their future and the field they must occupy. 2000 w. St Ry Jour—Feb. 28, 1903. No. 53917 D.

Electric Railway Bridges. Wilbur J. Watson. Remarks on the tendency of electric railways to approach steam railway conditions of loading and the effect of the many cars now operated upon existing bridges, discussing design, factor of safety, etc. 4000 w. Jour Assn of Engng Socs—Jan., 1903. No. 54158 C.

Engineering Preliminaries for an Interurban Electric Railway. Ernest Gonzenbach. Gives plans and recommendations embodied in a report on a proposed railway, showing the way in which certain conditions were met, with reasons. 3500 w. St Ry Jour—March 7, 1903. Serial. 1st part. No. 54065 D.

Northern Ohio Interurban Lines. An illustrated description of the Columbus, Delaware & Marion Ry., which is a part of an electric system which will eventually reach Cleveland. 4500 w. St Ry Jour—March 21, 1903. No. 54323 D.

Protected Third-Rail Interurban Road in Pennsylvania. An illustrated detailed account of the Wilkesbarre & Hazleton railroad in the anthracite coal regions, which is intended to compete with steam roads for freight as well as passenger business. 600 w. St Ry Jour—March 7, 1903. No. 54061 D.

Some Notes Respecting the Legal Status of Electric Interurban Railways. Gives information in regard to the legal status of electric railways in Indiana, Illinois, Ohio, Michigan, New York, Connecticut, and Massachusetts. 2800 w. Eng News—March 5, 1903. No. 54035.

The Performance of the Dayton & Troy Electric Railway Power House. An account of the performance of a direct-current power house supplying boosters for feeding the distant portions of the line, describing the equipment, character of the road, tests made, etc. Ill. 3800 w. St Ry Jour—Feb. 28, 1903. No. 53916 D.

The Providence & Danielson Ry. Illustrated account of this road which forms the completing line in a system of electric lines from Worcester, Mass., to Providence, R. I. It is for passengers and freight, and has an interesting adaptation of storage batteries. 2400 w. St Ry Rev—March 20, 1903. No. 54341 C.

Urban and Interurban Locomotion in America. Robert P. Porter. Reviews the report of Lieut.-Col. H. A. Yorke and discusses the projected extensions in Greater New York, in the present article. 3000 w. Engng—March 13, 1903. Serial. 1st part. No. 54193 A.

Italy.

The Status of the Electric Traction Problem in Italy (I Termini del Problema della Ferrovia Elettrica Italiana). P. Lanino. A discussion of the relation of electric traction to the railways of Italy, urging the standardisation of apparatus and methods. 3000 w. L'Elettricità—March 8, 1903. No. 54244 D.

Johannesburg.

The Johannesburg Electrical Scheme. Notes indicating the character of the proposals and the different items of expenditure relating to a scheme for furnishing electric light, power, and tramways. 3000 w. Elec Rev, Lond—Feb. 20, 1903. No. 53869 A.

Massachusetts.

The Experience of Massachusetts in Street Railways. Louis D. Brandeis. Read at Nat. Con. on Munic. Ownership & Pub. Franchises. An account of the development of street railway lines. 3500 w. St Ry Jour—March 7, 1903. No. 54066 D.

N. Y. Subway.

A Complete Rapid Transit System for New York. Extracts from the report of William Barclay Parsons for the boroughs of Manhattan and the Bronx, with brief comments. Map. 1000 w. Ry Age—Feb. 27, 1903. No. 53888.

The Proposed Extensions of the New York Rapid Transit Railway System. Extracts from the report of Mr. William Barclay Parsons, explaining the work and giving reasons for the suggested improvements. 1200 w. Eng News—Feb. 26, 1903. No. 53853.

The Type of Controllers and Motors to be Used in the New York Subway. Illustrated description of the controller equipments and of the General Electric motors. 2500 w. St Ry Jour—March 14, 1903. No. 54115 D.

Westinghouse Motors for the Rapid Transit Subway, New York. Illustrated description of motors designed especially for this purpose, to fit the conditions and requirements. 1500 w. St Ry Jour—March 21, 1903. No. 54324 D.

Poles.

Side Poles for Electric Tramways. George G. Braid. Gives calculations relating to the strength and stiffness of side poles used for supporting the overhead construction work of electric railways. Mathematical. 1800 w. Elec Engr, Lond—Feb. 27, 1903. No. 54004 A.

Safety Devices.

Safety Devices for Tramway Trolley Wires. Donald Smeaton Munro. Gives an illustrated description of various devices used for protection against accidents. 1500 w. Elec Rev, Lond—March 13, 1903. Serial. 1st part. No. 54303 A.

Steam Motor.

The Purrey Steam Tramway Motor (Automotrice à Vapeur, Système Purrey). L. Pierre-Guédon. Describing a steam-driven motor car used on certain tramway lines in Paris; a water-tube boiler is used. 3000 w. 1 plate. Génie Civil—Feb. 28, 1903. No. 54204 D.

Stray Currents.

See Gas Works Engineering.

Surface-Contact.

The Dolter Surface-Contact System. Illustrated description of this system and its operation. A line in France has been at work for over a year and is highly praised. 2000 w. Engr, Lond—March 13, 1903. No. 54199 A.

The Surface-Contact Tramways of the Bois du Boulogne (Tramways du Bois de Boulogne à Contacts Superficiels). E. Dieudonné. A description of the Dolter system, now being tried in Paris; the contact switches are operated by electro magnets carried on the car. 2500 w. Revue Technique—Feb. 10, 1903. No. 54-207 D.

Test.

Test of Subway Motors. An account of these tests, which were the most exacting ever made in electric railway practice, and of the methods employed. 2500 w. St Ry Jour—March 21, 1903. No. 54325 D.

Third Rail.

The Third Rail on the Baltimore and Ohio. W. D. Young. States some of the difficult problems involved in the installation, with illustrated description of the general form of construction. 4800 w. St Ry Jour—March 14, 1903. No. 54113 D.

Tracks.

How to Lay Interurban Track in Cities. Extracts from a letter presenting the points of difficulty to be overcome, and giving an invitation for discussion of the various subjects. 2200 w. Munic Engng—March, 1903. No. 53941 C.

Track Construction of the International Railway Co. in Buffalo, N. Y. T. W. Wilson. Begins an illustrated detailed description of fine construction laid on concrete with electrically welded rails. 1300 w. St Ry Rev—March 20, 1903. Serial. 1st part. No. 54339 C.

Valtelline.

Main-Line Polyphase Electric Traction in Upper Italy (Elektrische Vollbahn mit Hochgespanntem Drehstrom in Oberitalien). E. Cserhati. A general illustrated description of the Valtelline railway, using the Ganz system. Two articles. 4000 w. Zeitschr f Elektrotechnik—Feb. 22, March 1, 1903. No. 54242 each D.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
American Telephone Journal. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* Philadelphia.
Electrochemist & Metallurgist. *m.* London.

Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Feilden's Magazine. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Straussenbahnen. *s-m.* Berlin.
Indian and Eastern Engineer. *m.* Calcutta.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* Chicago.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Electrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Electrical Conductors.

Conductors for Electrical Distribution; Their Materials and Manufacture, the Calculation of Circuits, Pole-Line Construction, Underground Working, and Other Uses. By F. A. C. Perrine, A. M., D. Sc. Size, 9½ by 6 ½ in.; pp. VII, 287; illustrations, 84; folding plates, 5. Price, $3.50. New York: D. Van Nostrand Company. London: Crosby, Lockwood & Son.

The author of this book has had an extensive and varied experience as a manufacturer of insulated wires and cables, as an electrical engineer, and as professor of electrical engineering at Leland Stanford, Jr., University. The results of this experience are embodied in the present volume, different chapters of which are devoted to conductor materials; alloyed conductors; the manufacture of wire; wire finishing; wire insulation; cables; calculation of circuits; Kelvin's law of economy in conductors; multiple-arc distribution; alternating-current calculation; overhead lines; the pole line; line insulators, and underground conductors. The book is fully illustrated and there are five separate plates of wiring charts. The account of the manufacture of wire, both bare and insulated, and cables is particularly comprehensive, and the volume as a whole is a most valuable treatise on electrical conductors, and will be of the greatest interest and service to the electrical engineering profession.

Launch Building.

How to Build a Launch from Plans, with General Instructions for the Care and Running of Gas Engines. By Charles G. Davis. Size, 7¾ by 5 in.; pp. viii, 159; figures, 45; plates, 14. Price, $1.50. New York: Forest and Stream Publishing Co.

The rapid development of the gasoline engine during the past few years has furnished such a convenient and economical motive power for small boats that a launch is now within the reach of a great many people who have hitherto been obliged to content themselves with a rowboat or, at best, a sailboat. To some men and to most boys there is an added satisfaction in having a boat built by themselves, and to such prospective builders the present little volume will prove very helpful. After an introductory chapter on general considerations, the actual boat building is taken up, and, with the aid of a number of illustrations, detailed instructions are given for constructing a wooden launch about 18 feet long. Gas and gasoline engines and their care and operation are then discussed, and the book is concluded with a lot of useful "wrinkles."

Roads.

Road Conventions in the Southern States, and Object-Lesson Roads Constructed Under the Supervision of the Office of Public Road Inquiries, with the Co-operation of the Southern Railway. Bulletin No. 23. Prepared under the direction of Martin Dodge, Director. Size, 9 by 6 in.; pp. 89; plates, 11. Washington: U. S. Department of Agriculture.

The Office of Public Road Inquiries, of the U. S. Department of Agriculture, cooperated for a period of about five months during the winter of 1901-2 with the Southern Railway Company and the National Good Roads Association in an expedition for building object-lesson roads in the southeastern section of the United States. A train, loaded with road-building machinery, travelled through the States of Virginia, North Carolina, South Carolina, Tennessee, Georgia and Alabama, stopping at eighteen different places. At each stopping place object-lesson roads were built and good-roads conventions held. Much interest was aroused and the good-roads movement was given a strong impetus. The expedition described in this report is only one of the many good works in which the Office of Public Roads Inquiries has been and is engaged, and many bulletins and circulars issued by this office give accounts of good-roads activity in various sections of the country.

Roads and Pavements.

A Treatise on Roads and Pavements. By Ira Osborn Baker, C. E. Size, 9¼ by 6 in.; pp. VIII, 655; illustrations, 171. Price, $5. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The object of this book is to give a discussion from the point of view of an engineer of the principles involved in the construction of country roads and of city pavements. The discussion is limited to the subjects indicated in the title, but it covers practically everything within these limits, in a manner both comprehensive and concise. The chapter list includes: Road economics; road location; earth roads; gravel roads; broken-stone roads; miscellaneous roads (including wheelways of steel and other material); equestrian roads and horse-race tracks; pavement economics; street design and city plans; street drainage; curbs and gutters; pavement foundations; asphalt pavements (including asphalt blocks, asphalt macadam and coal-tar roads); brick pavements (including the testing of bricks); cobble-stone pavement; stone-block pavement; wood-block pavement; comparison of pavements; sidewalks; and bicycle paths and race tracks. The real and fundamental value of the subject matter here outlined is enhanced by its systematic order and typographical arrangement. The author is the professor of civil engineering at the University of Illinois, and his book represents his knowledge of his profession as well as the results of years of observation and experiment; and it will be of great service in advancing the knowledge and practice of road and pavement construction.

Storage Batteries.

Storage Battery Engineering. A Practical Treatise for Engineers. By Lamar Lyndon, B. E., M. E. Size, 9½ by 6½ in.; pp. 382; illustrations, 177; plates, 4. Price, $3. New York: McGraw Publishing Co.

As its title indicates, this is a thoroughly practical work. By this is meant not a collection of mere rule-of-thumb matter, but a comprehensive and systematic treatise on up-to-date practice. While the fundamental principles on which all good practice is based are properly considered, not too much time is spent upon the purely chemical aspects of the lead accumulator, nor upon theoretical discussions. In the first part of the book, the storage battery itself is taken up, the lead cell alone being considered in full. After a general introduction, the different parts and the various types and styles of lead batteries are discussed in detail, their diseases diagnosed, and the remedies therefor supplied, and directions given for their installation, care, management and testing. The second part of the work deals with auxiliary apparatus, systems and applications of storage batteries, some of the topics treated being end cells, resistances, switches, boosters of all types, rheostats, circuit breakers, two-wire systems, three-wire systems and alternating-current systems. There have been many books written about the storage battery itself, although generally from a chemical, as distinguished from an engineering, standpoint, but this book is especially noteworthy for its very able discussion of the auxiliary apparatus which has taken the lead accumulator out of the laboratory and made it a commercial success in modern electrical plants.

Water Waste.

Water Supply and Prevention of Waste in Leading European Cities. Report to the Merchants' Association of New York by Columbus O. Johnson, Ex-Water Registrar of New York City. Size, 9 by 6 in.; p. 289. New York: The Merchants' Association of New York.

In anticipation of the appointment of the special water commission to investigate new sources of supply and check the prevailing waste, the Merchants' Association of New York, at its own cost, engaged Mr. Johnson to go abroad and investigate the water systems of the principal cities of Europe. He has collated some valuable information upon the whole subject of water supply, and more particularly upon the collection of revenue and the checking of waste, and the present report embodies the results of his investigations of the distribution of water, the detection and prevention of waste, and the system of accounts in the cities of Glasgow, Liverpool, Manchester, Birmingham, London, Paris, Cologne, and Berlin. Each city is taken up separately, and an appendix contains accounting forms and methods, water rates, and other statistics. An account is given of the operation in several British cities of the Deacon meter system for detecting and localizing waste, and considerable attention is paid to the use of meters in the different places visited. This report altogether is peculiarly opportune, and the Merchants' Association is to be commended on its public spirit in thus helping to solve the extremely important problem of an adequate and economical water supply for New York.

BOOKS ANNOUNCED.

Finances of Gas and Electricity Manufacturing Enterprises. By Wm. D. Marks. Second edition. Price, $1. Philadelphia: Consolidated Railway and Light Co.

A Systematic Method of Calculating the Dimensions of Direct-Current Dynamo-Electric Machines. By Carl Kinsley. Chicago: The University of Chicago Press.

An Alternating-Current Calculating Device for the Use of Electrical Engineers. By F. G. Baum. Second edition, revised and improved. Price $1. Stanford University. California: Stanford University Book Store.

A Text-Book of Field Astronomy for Engineers. By George C. Comstock. Price, $2.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

THE ENGINEERING MAGAZINE

"THE WORLD IS ITS FIELD"

VOL. XXV. JUNE, 1903. No. 3.

THE PANAMA CANAL: THE DUAL VERSUS THE SINGLE-LAKE PROJECT.

By Gen. Henry L. Abbot. With reply by George S. Morison.

General Abbot and Mr. Morison are not only engineers of pre-eminent distinction and international reputation, but the leading advocates of the two great projects for the Isthmian Canal. The following papers are supplementary to their more extended discussion of the question in this Magazine for December, 1902, and January, 1903. They are brief summaries of the essential points of the respective plans. It is unnecessary to do more by way of introduction than to call attention to the interest and importance of this finished debate by two of the world's highest authorities.—THE EDITORS.

IN Mr. Morison's paper which appeared in the January number of THE ENGINEERING MAGAZINE, and in a second which is printed in the proceedings of the American Society of Civil Engineers for the same month, he proposes to modify radically the plan adopted by the Isthmian Canal Commission, of which he was a member, not only in the mode of construction of the Bohio dam but also by abandoning about six miles of canal now largely excavated, below Bohio, and adopting a new location, much of it raised above the general level of the country, and involving three crossings of the bed of the Chagres river as well as an additional lock at Tiger Hill. It would seem therefore that there are three plans for the canal to be considered, which in order of date are: that of the International Commission of Engineers, known as the *Comité Technique,* that of the Isthmian Canal Commission, and that of Mr. Morison. The fundamental difference between them consists in the fact that by the first the regulation of the Chagres river is effected by two lakes, one of them created by a dam at Alhajuela and the other by a dam at Bohio, while by the other two plans only one lake is projected, at Bohio, but which is much larger and at a much higher level. The Isthmian Canal Commission and Mr. Morison both admit that the upper lake may ultimately be required for low-water supply, but propose to defer its construction.

Since Mr. Morison has misapprehended the action of the New Company when he states that it "rejected" the plan, advocated in my paper, in THE ENGINEERING MAGAZINE of last December, in favor of a plan with a higher summit level involving the construction of a feeder line from Lake Alhajuela, it seems desirable to explain the conditions more fully.

In preparing the project for a private company the *Comité Technique* was in duty bound to consider with the greatest care the element of cost. Many plans with different summit levels were prepared and carefully studied to develop the facts. The deeper the cut at the Culebra the greater would be the chance of accidental delays involving heavy interest payments, so near the completion of the work. It was hoped and believed that the low-level plan as defined in my paper could be completed in about the same time as the group of works at Bohio, and at practically the same cost as the plan at a higher level to which Mr. Morison referred, but as it was regarded as certain that this condition could be fulfilled with the latter, it was formally approved, but with the understanding that if no unexpected delays occurred the low-level project should be preferred; and all details were carefully arranged to permit the final decision to be deferred for several years without involving any loss of work already executed. Mr. Morison therefore does me too much honor in attributing a preference for this plan to me personally. It was the plan which the Company hoped and believed could be executed within the estimated cost. The conclusion was unanimous that without delays the two plans would involve about the same outlay, and I will add that it is my personal belief that the same will be true for a single or dual lake project even with the increased dimensions now contemplated to accommodate larger shipping. The following is a more detailed explanation of this low-level project of the Company.

The summit level is that of Lake Bohio, of which the highest stage above mean tide is fixed at 20.50 metres (67.3 feet), the medium stage at about 63 feet and the lowest stage at 18.75 metres (61.5 feet). For the lake projected by the Isthmian Canal Commission, and adopted by Mr. Morison, these heights are 92 feet, 85 feet, and 82 feet. It remains to consider what these heights imply.

It must be borne in mind that the topography of the country fixes the least height possible for a single lake, called upon to regulate the floods of the Chagres and to receive and store the supply needed to meet the demands of the canal in the low-water season. This height is about that adopted by the Isthmian Canal Commission, which at normal stages is about 22 feet above that projected by the *Comité Technique.* There are three grave objections to this increase.

The first is that it adds 22 feet to the height through which each ship that passes the canal must be raised and lowered. If, as generally admitted, a canal without locks is preferable to one requiring them, it follows that the addition of 33 per cent. to the height of the summit level is a distinct demerit. Furthermore, if the construction of the upper lake is to be contemplated ultimately, when it will be too late to correct this evil, why not avoid a permanent defect by making the lake a part of the original project?

The second objection is that the locality at Bohio is not well suited to receive more than two locks in flight, and this has led to the certainly objectionable lifts, ranging from 41 feet to 46 feet, (usually 42.5 feet, according to the stage of the lake as adopted by the Canal Commission. Mr. Morison reduces them by introducing a new canal level and an additional lock at Tiger Hill. Why not avoid the difficulty by lowering the level of the lake as is done by the *Comité Technique?* Such lifts with their enormous lower gates (83 or 84 feet high) are quite without precedent in a ship canal, and would certainly largely increase the risks of accidental delays, and even of interruption of traffic. By the project of the Company the lifts would range between 34 feet and 31 feet according to the stage of the lake, the usual being less than 32 feet.

The third objection to a single-lake project arises from the nature of the sub-strata at the site of the Bohio dam. This is a gorge probably due to the action of some ancient river, which has been filled up to the level of the present bed by tertiary deposits of clay, gravel, and sand. The dam projected by the engineers of the Company was of earth resting upon a solid bed of clay and sand that offered a suitable foundation. The borings indicated deep under-lying strata of gravel and sand which might permit percolation to a certain extent but, it was believed, not sufficiently to endanger a dam exposed to the moderate head contemplated. Such percolation would exert no influence upon the supply reserved for the needs of the canal in the dry season, since this would be held back in the upper lake above Alhajuela where no escape is to be.apprehended. By the single-lake project the conditions are radically changed. About 22 feet are added to the usual head of water, and the security of the reserve held in Lake Bohio for the dry season is endangered by percolation not easily estimated. Hence the Isthmian Canal Commission considered a masonry core extending to bed rock to be essential, adding enormously to the difficulty of construction and to the cost. Mr. Morison, by making use of recent data concerning sand filtration, arrives at an encouraging estimate of the volume of this percolation, but it would seem that he has overlooked the fact* that this permeable stratum lying far below the foundations of the dam, and extending an unknown distance into the region below, cannot be assumed to be affected by raising the water level below the dam, as he proposes to do by his additional higher canal level extending to his lock at Tiger Hill. Such raising would doubtless reduce seepage through the dam itself, but this is not what is to be feared. So long as the deep route for the water to filter to the sea below the foundation of the dam exists, the needed reserve is liable to escape. It would seem to be much the better plan to store it among the hills where it is certain to be safe, and thus avoid the necessity of adding 22 feet to the head acting upon these sub-strata.

But these three difficulties do not complete the objections to the single-lake project. The two-lake plan regulates the entire river from the point where it reaches the route for shipping to the sea. With a single lake, the first few miles, where hills contract the waterway, are exposed to the full force of the floods, and of the frequent freshets which during eight months of the year average two or three per month. The extension of the level of the lake nearly to Alhajuela would have little influence, for the volume unreduced must reach the wide lake, and as the upper part of the submerged district would be very shallow the chief flow would be confined to the deepest portion, which is the route followed by shipping. It is true that this extension of lake surface nearly to Alhajuela would do much to prevent the introduction of a small volume of silt into the ship channel; but the exclusion of the silt, and of sand and gravel rolled along the bottom as well, will be better effected by transforming the torrential river into a quiet stream of practically uniform flow, as would be done by the upper lake with its outflow regulated as contemplated.

Mr. Morison introduces another point, upon which I touched lightly in my paper, because it is independent of the question of whether one or two lakes shall be preferred. Reference is made to the mode of regulating the outflow of Lake Bohio.

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* The language in Mr. Morison's article in THE ENGINEERING MAGAZINE may perhaps make this checking of deep percolation by raising the water level below the dam appear to be a forced construction of his meaning, but in his article in the Proceedings of the Society of Civil Engineers he reduces the seepage as computed in his paper on the Bohio dam from 40 cubic feet per second to 28 cubic feet, due to a reduction of head from 90 feet to 60 feet; and I think therefore I rightly understand his idea, although it is not easy to see why both heights should not be considerably increased.

The Isthmian Canal Commission provides for automatic regulation, allowing the flow to pass over a fixed spillway 2,000 feet in length. It estimates that with 5 feet on the crest about 78,000 cubic feet per second will escape, and with 7.5 feet about 140,000, and that the latter will more than meet all demands.

The *Comité Technique* preferred the system of regulated outflow that has proved to be an entire success on the Manchester Ship Canal. The weir crest would be fixed at about a metre (3.3 feet) below the normal level of the lake. Counterpoised gates operated independently would permit the outflow to be easily and rapidly regulated. To secure a uniform outflow never exceeding 1,200 cubic metres (42,380 cubic feet) a length of crest of about 144 metres (472 feet) would be required, based on a largest flood discharge of the river at Bohio of 2,640 cubic metres (93,236 feet) per second for 48 hours, the two lakes co-operating. While an automatic system of controlling the overflow is undeniably the more simple it contemplates a constantly increasing discharge during a flood, and leaves the maximum volume to be determined by the maximum height of flow over the crest. With a system of movable gates this discharge admits of regulation to a uniform and safe volume during the entire period, an important matter when the capacity of the channel below is limited, as is the case below the Bohio dam. The duty of the operator here involves no real difficulty, since he has only to watch the level of the water in the lake and below and be guided accordingly. Under ordinary conditions the automatic system would probably meet all needs, but in floods the results would be more doubtful. The details of the plans of the Commission for protecting the lower districts, including the canal and railroad, against inundation are not yet published, but as damages to the railroad have usually occurred at such times the matter was carefully investigated by the *Comité Technique,* and the conclusion was reached that overflow should be restricted to 1,200 cubic metres, per second (42,380 cubic feet). The automatic-regulation plan admits a volume estimated at 80,000 cubic feet or more to pass in floods. The introduction of a new canal level 26 feet above tide would suggest that Mr. Morison has doubts on the subject. The substitution of a system of movable sluice gates would equally effect the object, and probably at much less cost. Furthermore, the two systems admit of combination.

The only merits which are claimed for the higher level incident to Lake Bohio in the single lake project appear to be: (1) a saving of expense in the deep cut through the Continental divide, which as appears above cannot be established without a complete technical discussion including the reduced costs at Bohio and all other items involved; (2) the reduction in the volume of silt carried by the river to the route traversed by shipping, which as has been shown above is better effected by an upper lake; and (3) the increased area of Lake Bohio (about 40 square miles) affording a more convenient basin for the accommodation of shipping in transit. In answer to this latter claim it may be stated that the lake as projected by the *Comité Technique* (about 23.5 square miles in extent) would afford all the space needful for this purpose, and it would appear that there is little advantage in increasing by 70 per cent. the evaporation, and hence enlarging the volume required for canal reserves during the dry season. The greater portion of the added area would be shallow and much of it would soon be invaded by tropical growth.

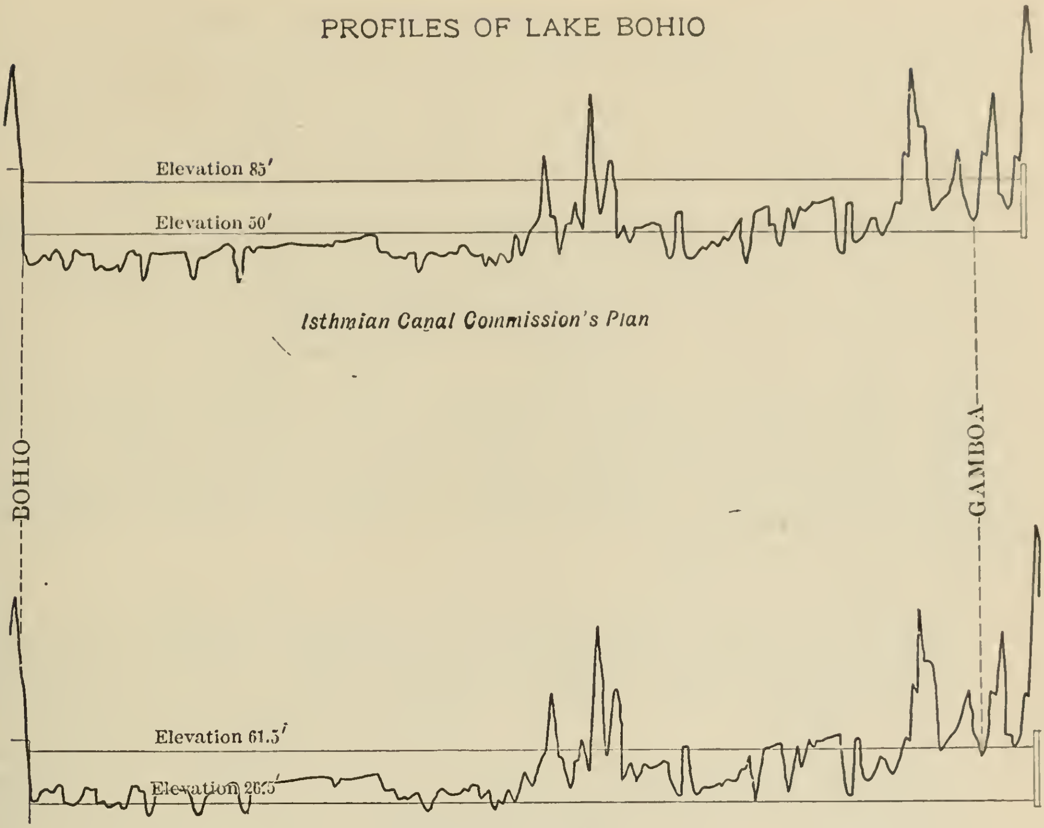
In fine, then, the dual-lake project regulates the Chagres throughout the entire valley, giving a canal absolutely free from currents or silt and sand deposits, and at a considerably lower summit level than is possible when a single lake is called on to do the work. By it the difficulties of construction of the Bohio dam are greatly reduced, and the objectionable lifts at that locality are brought within the limits of experience. The low-water reserve is secured beyond cavil. It is interesting to note that all the technical objections raised against the Panama route by hostile witnesses at the hearings of the Senate Committee on Interoceanic Canals, in 1902, prior to the passage of the Spooner Act, have more or less force as against a single-lake project, but fail utterly as against the dual plan.

THE ADVANTAGES OF LAKE BOHIO AT THE HIGHER LEVEL.

By George S. Morison.

BECAUSE a canal without locks is preferable to one requiring them, it does not follow that an addition of one-third to the height of a summit level is a distinct demerit. When locks are once adopted the whole system of canal is altered. The limiting dimensions of the locks are imposed on commerce. The canal is changed from a salt-water to a fresh-water canal. A summit level is established and a water supply must be maintained for this summit level. While a tide-level canal may be preferred to a canal with a summit level, the summit level is not without its advantages, and when a summit level is adopted, that plan should be selected which is the best possible plan for a canal with a summit level—not that which most nearly approaches a tide-level canal. The plan which Gen. Abbot refers to and which, though set aside, would undoubtedly have been

PROFILES OF LAKE BOHIO



LAKE BOHIO, ON THE SINGLE-LAKE AND DUAL-LAKE PLANS.

preferred by the *Comité Technique,* except for the additional time which it was feared its construction would involve, required three locks on the Pacific side and two on the Atlantic. The plan adopted by the Isthmian Canal Commission required the same number of locks, although those on the Atlantic side were given an excessive lift which the writer thinks it would be wise to avoid. The time required to pass the extra lock does not appear of material importance. The time required to pass through the canal will be a matter of convenience of meeting points more than of close calculations of speed. As many vessels as possible will meet in Lake Bohio, and under any plan it will take longer to pass from Panama Bay to Lake Bohio than from Colon Harbor to Lake Bohio. The advantages of the lake at the higher level are the increased area, the increased depth through a large portion of it, and the increase of cross section through the narrow portion between San Pablo and Gamboa, this increase being ample to provide for the additional flood discharge which may be expected if no water is stored above Alhajuela. The accompanying profiles, on which the normal elevations of the water in the lake under the two plans and bottom levels 35 feet below these elevations are given, show that there would be a restricted channel for practically the whole length of the lake advocated by Gen. Abbot, while there is very little restricted channel at the higher elevation. The advantage of the higher lake will become even more manifest by comparing these profiles with the map on page 506 in the January number of THE ENGINEERING MAGAZINE.

The other point relates to possible seepage from the lake. In this matter Gen. Abbot refers to a paper by myself in the Transactions of the American Society of Civil Engineers, entitled The Bohio Dam, which paper contains an estimate of the possible maximum seepage which might pass under this dam. Gen. Abbot, however, has missed the meaning of those calculations. The calculation of the seepage was based entirely on seepage through "the permeable strata below the foundations of the dam," as appears from the following quotation from this paper:

> "Either dam proposed would itself be practically impervious. The puddle wall in the last design may be considered entirely so, and the filling generally would consist of water-tight earth, loose sand and gravel being excluded. * * * * The distance between the up-stream slope * * and the down-stream slope * * is 2,400 feet in a straight line; the actual distance which water must travel to pass between these points is at least ½ mile. To this should be added the distance from the dam to the place above, where the geological channel may connect with the present river; this distance is not accurately known, but it can hardly be less than ½ mile; in calculating the seepage, however, it has been entirely neglected, and the distance which water must travel through a bed of sand and gravel has been assumed to be 2,500 feet."

It makes no difference where the water goes, whether it passes out to the sea by some remote course or rises through the bottom of the Chagres at some lower point, the amount of seepage is directly as the head and inversely as the distance, and the calculations given in that paper assumed maximum conditions. The conclusions were such that the writer feels that this whole question of seepage is of so little importance that it has no real bearing on the height of the dam. Furthermore, this seepage would be through sand and gravel which would gradually be silted up with the finer material brought down by floods. It would be greatest when the work was first completed. On the other hand, although the Alhejuela Dam would be founded on rock and be an excellent structure, the country above is a limestone country, and not only are fissures in limestone rocks the most treacherous causes of leakage, but the constant tendency is for them to enlarge.

THE PROMOTION OF INDUSTRIAL EFFICIENCY AND NATIONAL PROSPERITY.

By John B. C. Kershaw.

The past few years have been marked by an almost phenomenal advance in the introduction of labour-saving machinery and methods. But, as Mr. Kershaw says, "a machine without a skilled worker determined to obtain from it the highest possible yield, can effect little in the reduction of the cost of manufacture." That is his theme—how to increase the productive capacity of the worker and make him willing to use it to the utmost. There is no more important question now before the industrial world.—The Editors.

> "The more closely capital and labour are associated for mutual advantage the better. For labour to hamper capital is ruinous. For capital to starve labour is disastrous, even to capital, for labour in the concrete constitutes the mass of consumers. If work-people cannot buy, consumption must fall to a minimum."

THE above extract from an article on "American Competition," contributed by Mr. George Howell, F.S.S., to one of the leading British engineering weeklies in 1899, forms a fitting introduction to the present series of articles on the "Promotion of Efficiency in Industry."

It is generally admitted by all competent observers, that the struggle of the three leading manufacturing countries of the world, namely, Germany, the United Kingdom, and the United States—for supremacy in the world's markets, will grow keener with each succeeding year. The extent to which Britain has lost, or is now losing, ground in this struggle is debatable, and widely different views are held concerning the alleged loss of position.* Even those who assert that the loss on the part of the United Kingdom is largely imaginary, agree that the *future* with respect to the maintenance of British industry and commerce is not without anxiety, and everyone admits that to retain the industrial position won by British manufacturers during the century which has just closed will require the best energies and the utilisation of every possible help. Even Sir Alfred Bateman, the compiler

* See articles in *The Nineteenth Century,* May, 1902, and *The Monthly Review,* June, 1902; also Board of Trade memorandum upon Trade of the United Kingdom, Germany, and United States, 1902, p. 30.

of the Board of Trade report just referred to, is slightly pessimistic in his views regarding the future.

One of the chief factors in lessening the cost of production of manufactured articles is the increased speed of output which follows the use of machinery in the hands of highly skilled workers, whose chief aim is to obtain the maximum of output per normal working day. In the past, English manufacturers and workers have been slow to recognise the importance of this factor, while the rapid advance of the United States as a manufacturing country has been largely due to the recognition of this connection between rapidity of manufacture and low cost, and to the introduction and use of machinery in every possible case.

Machinery of the latest design, however, is now being introduced into British industries, and British manufacturers can no longer be reproached with their supineness in this matter. A machine, however, without a skilled worker determined to obtain from it the highest possible yield, can effect little in the reduction of the cost of manufacture of the particular article produced, and it is questionable whether British industries have yet attained the latter condition of success.

The writer of the series of articles entitled "The Crisis in British Industry," which appeared in *The Times* towards the end of 1901, certainly proved that in most of the industries carried on in the United Kingdom there is decided room for improvement in the efficiency of labour. It is not necessary to devote space in the present series of articles to a consideration of the question whether this state of affairs is due to the "ca'canny" teaching of trades-union leaders, or whether it is the result of other causes. Such a discussion is outside the scope of this inquiry, which deals with the methods and systems at present in use in Germany, England, and the United States, for obtaining that active co-operation between capital and labour which is now absolutely essential for the maintenance of position as a manufacturing country.

Methods:—In Germany the movement has been in the direction of reform in the social condition of the workers, rather than towards high wages and bonus systems. In most of the larger German engineering works we find elaborate arrangements and organisations for the comfort of the workers during working hours. The State system of insurance against sickness, accident, and old age, also assists in ameliorating the lot of the German worker, and renders him content with longer hours of work and with lower wages than those customary in the United Kingdom and America.

As an example of the sanitary and other conveniences for increasing the comfort of the workers in Germany, we may take the arrangements at the machinery works of Ludwig Loewe & Co., in Berlin. The factory buildings are well-lighted, and well-ventilated, and are warmed by hot air during the colder months of the year. The men as they enter and leave the works pass through a washing and wardrobe room, where each is provided with a numbered cupboard for his working and outdoor clothes. These cupboards are thoroughly inspected by a sanitary officer once a fortnight, and are so designed that it is impossible for dirt to accumulate either above or below them. The washing places consist of long troughs placed between the rows of cupboards, and as the men leave work water is turned on in order to provide a running stream through these troughs. In winter, the water is heated. The floor of this room is of cement, and it can therefore be thoroughly cleansed when necessary by aid of a hose pipe and a stream of water. Messrs. Loewe claim no philanthropic motive in providing these facilities for cleanliness and comfort. They say that to consider the well-being of their employees is a wise policy, simply from a selfish point of view. Their men are reported to be of superior appearance, and it is stated that few are to be seen leaving the works in a dirty or untidy condition.

A second example of modern German methods of promoting the efficiency of labour is to be found in the electrical engineering works of the famous Nuremberg firm, Schuckert & Co. In addition to its obligatory contributions to the sick and accident funds, the firm contributes largely to pension funds for the aged, widows, and orphans, these funds having been started by a gift of £40,000 from the heads of the firm. The contributions to these funds by the workers are made on the following basis: members of the staff (i. e., all in receipt of monthly salaries) contribute 4 per cent. of their salaries. All sums contributed in this way are refunded without interest, if the member concerned should leave the firm. After five years, any member invalided is entitled to a pension equal to 10 per cent. of his last year's salary, and this pension is increased 2 per cent. for every additional year's service, until a maximum of 70 per cent. of the salary is arrived at. In case of death, the widow draws for the rest of her life half of the sum due to her husband, and for every child, an addition to this of one-tenth is made. All men in receipt of weekly wages are enrolled as members of their own pension fund after five years' service; and they are not expected to contribute towards the fund. When invalided they are entitled to receive £1 per month, with 1 shilling extra for every further year of service above five. The maximum pension is reached with 50 shillings per month. The firm also encourages the men to insure their lives in ordinary life assurance societies, and special terms have been obtained for employees of the Schuckert Company. Profit-sharing has also been instituted at the Nuremberg works, according to a writer in *Engineering,* on the following basis:

> "All employees, of whatever rank, share in the business profits after one year's service. The gratifications have, in the case of the men, varied between 4 shillings and 300 shillings per year. The firm invests these small sums in the municipal savings bank when desired to do so, and when such an account has reached the amount of £25, the sum is transferred to the business capital of the firm; the ordinary shareholder's dividends are then allowed. A workman's share of this kind is limited to £100."

As regards other agencies for improving the condition of the workers, a co-operative supply association on the cash principle was started early in 1896. Beer and other light refreshments can be obtained *in the works,* and the profits of the canteen flow directly into the mens' pension fund without any deduction. In 1896 they amounted to £700. Special training schools for mechanics and clerks are carried on by the firm, and baths for the men and members of the staff have also been built at the cost of the Schuckert Company. A large evening continuation school for the children of the employees, has been built by Mrs. Schuckert at a cost of £15,000. In this school the boys receive special instruction in drawing, and the girls in domestic subjects. In concluding a description of this works, a writer in *Engineering* says:

> "We shall hardly commit a mistake when we ascribe part of the success of the E. A. G. to this policy of making every employee take a direct interest in the affairs of the firm, and offering him reasonable inducement to stay with the company."

The recent financial troubles of the Schuckert Co. are to be ascribed to unwise company promoting on the part of the managing directors, and not to any defects in the works organisation.

At the German Niles Tool Works—a manufactory recently established near Berlin at a cost of £300,000, in order to produce the American types of machine tools—from 1,200 to 1,500 men are now employed, although manufacturing operations were only commenced in December, 1899. Speaking of the sanitary and social features of this modern works, *Engineering* says:—

> "The men's welfare, protection, and comfort, have received the most careful and effectual attention. The grass plots and trees on the site and between the buildings may strike the manufacturing engineer accustomed to crowded yards and rooms as a little odd. But order and

neatness are as desirable outside as inside, and tidiness throughout is a better testimonial to efficient management and supervision than that appearance of ever-busy activity which leaves no time for clearing up."

The washing and locker arrangements resemble those in the works of Ludwig Loewe & Co. (described above) with this improvement, that each man is provided with an enamelled wash basin, each basin being numbered to agree with the locker facing it. Clean warm water for washing purposes is provided all the year round. A bathroom adjoins the wash and locker room, and is provided with twenty separate bathing cells. Each man in the firm's employ is allowed half-an-hour once a week, for the use of these baths, and *no deduction* is made from his pay for this loss of time. A ticket system is used to enable each man to have a bath once in seven days, and the twenty bathing rooms suffice to allow 1,860 men to use them per week, between the hours of 8 and 7. The firm also provides a well-arranged dining hall for the use of the men, with gas stoves for cooking the meals brought by the men themselves or by their families. A canteen is provided in the works, and sandwiches, tea, coffee, and beer, may be taken into the shops for consumption during working hours. This canteen is managed by the firm and profits flow into the men's pension fund. A well-appointed surgery is also provided in the works, a certificated male nurse being in charge of this department.

The arrangements for promoting the physical and social comfort of the workers at these three works may be taken as typical of the larger German engineering establishments, and no practical purpose would be served by multiplying similar examples of the German methods of obtaining co-operation between employers and employed. Mr. Barnes, the Secretary of the Amalgamated Society of Engineers, broadened his mental horizon in 1899 by making a tour of German engineering works, and his report contains the following remarks:

"The general protection of workmen and provision for their comfort, is much more complete than in this country, and the shops are more spacious and cleanly.........Another common feature is the modern appearance of most workshops, and the use of first-class appliances. Everywhere new factories are building, machinery is being put down, and a great deal of that at work is dated this year or last. A no less marked feature common to German workshop life is the leisurely manner in which the men go about their work. Although piece work is common, I saw nowhere any bustle. With one exception, in all the shops visited men smoked during working hours, and in most of them there were canteens or other provision for getting refreshments while at work."

In 1901 the members of the English Institution of Electrical Engineers made a similar tour in Germany, and all those who took part in this were loud in their praises of the sanitary and social organisation of the works they visited.

Even in the matter of protection for the workers in dangerous trades, in which it might be supposed that Britain led the way, it is questionable whether manufacturers are not more hampered by restrictions in the Fatherland. The following extract from the *Zeitschrift für Elektrochemie* shows the regulations in force in the manufacture of lead secondary cells, an industry which is much more extended on the continent than in the United Kingdom:

1. No work connected with the manufacture of lead or its compounds shall be permitted in ordinary living or sleeping rooms.
2. The rooms or work places must be kept as clean as possible, and must be well ventilated. The floors must be washed daily, or swept after sprinkling with water.
3. Washing places must be provided for the workers, in addition to suitable accommodation for storing and changing their ordinary clothing.
4. Special clothing must be provided and worn by the workers during working hours.
5. Tobacco smoking and chewing must not be permitted during working hours.
6. Food and drink must not be stored or partaken of in the working rooms.
7. Meals must be eaten in a separate room, completely separated from those in which manufacture is carried on. Before eating, the workers must change their clothes, wash their faces and hands with hot water and soap, and rinse out their mouths with clean water. These precautions are also to be carried out when leaving the factory at night.
8. A periodic medical examination of the workers must also be made, and those found to be suffering from lead poisoning, or from any disease predisposing thereto, are to be excluded from the factory until restored to health.

The special dangers of the work must be explained to all applicants, before permitting them to start work in the factory.

In the United Kingdom, the majority of works and factories are still conducted on the *"laisser faire"* principles of the Manchester school of economists. The teaching of this school results in paying the worker the smallest possible wage, and in making none but the legally necessary provisions for his social or physical comfort. Under these conditions of employment, the usual relation between employers and employed is one of antagonism. The conversion of private firms into joint-stock companies in recent years has still further tended to widen the breach between capital and labour.* The directors of a few

* See *The Fortnightly Review,* May, 1900, "Joint Stock Enterprise and Manufacturing Industries," by John B. C. Kershaw.

of the larger and better managed works have, it is true, recognised the unwisdom of treating their employees rather worse than their machines, and have instituted social and other agencies for the amelioration of the life of the workers. In these cases, the agencies are on the same lines as those found in Germany. Systems of profit sharing, and other schemes for the social or educational advancement of the worker, are, however, exceptional in English works and factories. The larger number of instances given, as compared with those for German and American works, is simply due to the greater ease with which details can be obtained, concerning the movements that are in progress in my own country. Perhaps the most modern examples of enlightened treatment of workpeople in Britain are to be found at Port Sunlight and Bournville. At the former place Messrs. Lever Bros., Ltd., have erected a model village for the housing of their work people, the houses being let to tenants at rentals which, in view of the accommodation, compare favourably with those asked for ordinary working-class property. A striking feature of these "cottages" is that they are built in semi-detached blocks; each cottage contains a bath, and is provided with a fair sized garden. The soap factory at Port Sunlight was erected in 1889, and the employees are now said to number 3,000. The village comprises six hundred houses, and four miles of roadways, widening out at each junction into open spaces. A schoolhouse for five hundred children, mens' and girls' club houses, a public kitchen and public hall, have been erected, and a park, bowling green, and cricket ground have been laid out and presented to the village,—all these institutions being built or founded at the firm's expense.

The reasons which have induced this firm to build houses, rather than to distribute cash to their employees, are fairly* stated in the following extract from a speech recently delivered by the chairman of the company:—

> "In order to produce fine men and women it was absolutely essential that the children must be brought up from childhood in healthy and beautiful surroundings, for nothing else would so help and elevate them. If they took a working man and put him in a back slum at the east end of London, his children would grow up under conditions which choked and stifled every human impulse of their nature, and he felt that from what they were doing at Port Sunlight the children would receive greater benefit than could possibly accrue to them by the distribution of money to their parents, however liberal that distribution might be."

* Writing on April 4, 1901, the secretary of the company informed me that the receipts from the cottages have not sufficed to balance the expenditure upon rates and maintenance, and that on January 1st, 1901, the rents were raised 9 pence to 1 shilling 9 pence per week, according to the size and style of the cottage occupied.

The Bournville scheme, founded in connection with the works of Cadbury & Sons near Birmingham, is on somewhat similar lines. The estate which Mr. Cadbury has vested in trustees at Bournville covers about 330 acres, and with the cottages erected on it, is valued at between £170,000 and £180,000. Nearly one-half of the three hundred and seventy cottages on the estate have been sold at cost price to the tenants, 2½ per cent. and 3 per cent. being charged for the money loaned to complete these purchases. The remaining cottages and shops are let to weekly tenants, and the rents of these and the ground rents for the whole estate are paid into the funds of the trust. There are in addition two hundred allotments, and gardening classes also cultivate portions of the estate, under the Worcestershire County Council. The total rent roll is £5,246 per annum, and the surplus after deducting maintenance charges, is to be devoted to the development of this and other estates. This is the feature which distinguishes the Bournville scheme from those worked at Saltaire and Port Sunlight, and takes it out of the category of purely business speculations. Mr. Cadbury has stipulated that in any future estate purchased and developed under his trust deed, only 1/15 of the ground shall be covered by factories; and that the buildings for the workers shall only occupy ¼ of the land on which they are erected. The remainder of the estate is to be preserved as open land for the benefit of the inhabitants.

A large number of other firms in the United Kingdom carry on profit-sharing schemes of diverse character, the amount distributed to the work people being in the form of a lump sum based on the profits in the previous year. In some cases a definite percentage on the annual wages is granted; in other cases the owner of the works decides for each individual worker.

As an example of the latter, the profit-sharing scheme of Mr. J. P. Hartley at Fazakerley near Liverpool may be noticed. At this works the profit-sharing scheme was initiated in 1885. A certain percentage of the profits is set aside each year for distribution amongst the employees, four-fifths of whom are women and girls. The rates of wages paid are rather above the standard rates of the district. The participants receive their share in cash personally from the owner, at an annual Christmas gathering. The sum received varies, and is based partly upon the wages, and partly upon the thoroughness of each individual's work in the preceding year. The total amount distributed in this way in sixteen years has been nearly £29,000. In the year 1900, £3,140 was distributed to 690 employees, the majority of whom were women and girls.

As an example of profit sharing based on a fixed percentage of the profit and wages, the scheme in operation at the confectionery works of Messrs. Clark, Nickolls & Coombs in East London may be described. The number of employees is, in this case, between 1,500 and 1,600. The profit-sharing scheme was inaugurated in 1890. One-half of the profits, after payment of 6 per cent. on the ordinary share capital, are set aside each year as a bonus fund. A portion of this bonus is paid over to the employees in cash; the remainder is invested as a provident fund, from which payments are made in cases of sickness, marriage, or death. A superannuation fund has also been started by this firm. In the period 1890-1900, £45,025 was distributed to the workers under the scheme. In the latter year, the bonus amounted to £9,500, on a wages list of £60,000, and the number of participants was 1,224.

Similar schemes are in operation at the works of the South London Gas Company, and of the Thames Ship-Building Company. The former company employ on the average of 3,000 work people, and in the period of 1890-1900 the large sum of £126,283 was distributed under the scheme, to the regular workers. The company have now appointed two working men directors to the board, as the value of the company's stock held by the workers is over £53,000, the average holding being £46 per man.

The Thames Ship-Building Company have worked their profit-sharing scheme since 1893, and in the eight years ending in 1900 they have distributed £63,911 to their workers, an amount equal to 4 per cent. on the wages. The managing director of this Company has stated that the scheme, "has helped to improve the relations between the Company and its employees, and is slowly but surely convincing the latter that their interests are the same as those of their employers."

The old-age pension scheme of Messrs. Colman of Norwich is an example of another method of promoting co-operation between the employers and employed. According to "*Commercial Intelligence*" of September 1899:—

> "Messrs. Colman propose to provide at their own expense a pension of 8 shillings a week for all their employees who shall be in their employment at the age of 65, and who have given evidence of their willingness to increase the proposed pension by a contribution of their own. To put this disposition of self-help to the test it is stipulated that all members who join the pension fund will be called upon to pay a mimimum sum of 2 pence a week.
>
> "The whole of these weekly payments, with compound interest at 3 per

cent., which the company guarantees, will then go towards increasing the 8-shilling pension of the firm to some larger sum which will depend upon the precise contribution of the men. Should a workman leave the service of the company, or die before he reaches 65, all his contributions, plus the 3 per cent. compound interest, will either be returned to him or be placed to the benefit of his widow or heirs."

At the ship-building yard of Messrs. Denny & Co., at Dumbarton, a somewhat novel system of rewards is in operation.

The men employed at this works are asked to write down and bring to the notice of their chiefs, ideas for improving the machinery or processes in use; and if adopted their ideas are paid for. In the five years 1894-1898, one hundred and thirty-four men claimed payments under this scheme, and £181 was distributed to eighty of these claimants. In some cases the ideas led to patents being applied for and granted.

As final examples of English methods, the schemes of Messrs. Furness, Withy & Co., of Hartlepool, and of Messrs. Armstrong, Whitworth & Co. of Newcastle, may be briefly referred to. According to the *Times* of July 14 last, Sir Christopher Furness announced at the annual meeting of the former company that:—

"The directors have decided to increase the ordinary share capital by 500,000 ordinary shares, with the view of inducing workmen connected with the establishment to take shares. The chairman said that he was prepared to advance to them at the rate of 3½ per cent. the amount they required to enable them to become shareholders. The dividend declared was 10 per cent., together with a bonus of 10 per cent. on the ordinary share capital."

Messrs. Armstrong, Whitworth & Co. inaugurated their profit-sharing scheme in 1897. All employees and officials of the company are urged to become shareholders, and 4 per cent. is paid on the sums invested, plus a bonus increasing with the dividend declared upon the ordinary share capital. The limit of invested capital for an employee is fixed at £200. On June 30th last, the amount deposited by the participators in the profit-sharing scheme reached a total of £139,474, and the number of individual depositors was between 2,500 and 2,600. These figures were kindly supplied to me by the secretary of the company for the puropes of this article.

American Methods.—In the United States we find, as one would expect in the country which has done the most to develop the use of machinery in all industries, elaborate arrangements for obtaining the co-operation of the workers. In some few instances these take the form of social agencies, but in the majority of instances a bonus or premium system based on a high normal level of wages is employed, and every man is allowed free scope for individual effort and ability. The comparative feebleness of trade unionism in the States has undoubtedly facilitated the introduction of this system of allowing each man a free hand, and of paying him exactly what he can earn. Whether the conditions which have favoured its introduction will continue, is doubtful, in view of the spread of militant unionism in the States. For the present the system is wonderfully effective. Various systems of bonus payment are in use, to act as incentives to large and rapid output, and a description of one of these will therefore serve to cover the methods employed at a large number of American works.

The Bethlehem Steel Company has adopted a system, which was described by Mr. H. L. Gantt in a paper read before the American Society of Mechanical Engineers in 1901. For all the larger pieces of work put into the shops, a chart is prepared showing the best methods of performing each operation, and the minimum time requisite. The sum of these times is the standard time required to complete the job under normal conditions of work. The man in charge of the work is paid a fixed day wage, and in addition a bonus or premium depending upon the saving in time with which he completes the particular work in hand. The co-operation of foremen and under managers in the working of this system is obtained, by paying them a bonus, increasing with the number of men under them who earn premiums on their weekly work.

The system is said to have worked admirably in the shops of the Bethlehem Steel Company, and since its introduction the output of the machine shop has been doubled, without any increase in the number of men employed.

This system is only a modification of that described by Mr. F. A. Halsey, in a pamphlet on "Premium Systems of Payment in Workshops," published in 1899. The system described by Mr. Halsey was in use at that time in American works, and consisted in fixing a standard time in hours for each particular piece of work, and in paying to the worker one-third of the saving in cost effected by any reduction upon this standard. The system was said to work well, provided that the standard was not fixed too low. As compared with profit-sharing, it was claimed that the worker benefitted *at once* from his industry instead of having to wait six to twelve months for his reward. A further advantage claimed was that the lazy and incompetent did not share in the gain, whereas in the usual schemes of profit-sharing no attempt was made to discriminate between the two classes of workers.

With regard to the general effects of the premium system, an English engineer states in *The Times* issue of December 3, 1901:—

> "While in Pittsburg, I went closely into the working of this system in one of the largest and most important electrical engineering establishments in the world. In the actual week's wages sheets which I inspected there were over a thousand men who had earned premiums. The premiums varied from 25 per cent. to about 100 per cent., over the wages, and an examination of almost the whole of the premium tickets revealed the fact that the vast majority of those who had earned high premiums were English workmen from the Manchester and Sheffield districts."

As to other methods of bonus payment, the United States Steel Corporation is introducing a somewhat similar system for obtaining active co-operation from its foremen, managers, and departmental heads.

According to Mr. Schwab, the managing director of all the steel plants under the combine, every foreman and departmental head employed by the corporation is to be given a percentage of the profits—paid to him in cash—in addition to his fixed salary. The recipients will be free to utilise this bonus payment as they please, but facilities will be given for investing it in the stock of the corporation. This system dates from January 1st, 1902, and has now been extended to all classes of workers employed by the Steel Trust. On January 8, 1903, it was announced that 12,000 employees had become shareholders in the company and had subscribed for £416,000 of stock.

The *Electrical Review* of New York states that the American Steel and Wire Co. are instituting a pension department, which will provide pensions for old and faithful employees, in accordance with their years of service. It is reported that this company, which employ between 25,000 and 30,000 men, will provide the whole of the funds required for this pension scheme, without the aid of any contributions from the men themselves. This scheme was to come into operation on January 1, 1902.

On account of the wide-spread adoption of bonus and premium systems of payment in the United States there is considerably less activity in the promotion of social schemes and agencies for the benefit of the workers than in England and Germany. The following details of the organisations at two works, however, show that America is not entirely without examples of enlightened treatment of work-people, apart from the pecuniary rewards of labour.

The National Cash Register Co. of Dayton, Ohio, maintains a large number of social and educational agencies for the benefit of its work-people. This firm employs a large number of women and girls, and they state that by giving these workers chairs with high backs and foot rests, in place of uncomfortable stools, they obtain more work in 7¾ hours than was formerly obtained in 10. Lifts have also been provided, to save the physical strength of the women and girls, and coffee and other refreshments can be obtained in the factory at cost price. A hall where physical exercises are indulged in by the employees morning and afternoon, baths which can be used during working hours without deduction of pay, a dining hall, a free dispensary, a library, a "rest" room, and a dancing school, have all been erected, and are worked at the firm's expense. According to Mr. J. H. Patterson, the president of the company, the result has been "to show that kindness pays," and the advantages and benefits conferred upon the work people are said to have been abundantly repaid.*

Another example of this kind is offered by the pickle factory of H. J. Heinz & Co., at Pittsburg. This works gives employment to about 2,000 work people, and the main factory covers 13 acres of floor space. Separate dressing and cloak rooms are provided for the men and women workers, and each woman is provided with a locker, and a neat working dress. Baths and dining halls are provided for each sex. A circulating library has been formed in connection with the dining hall, and this is said to be largely used by the women employees. Refreshments are supplied in the factory at cost price, under the management of the firm. The entertainment of the workers is provided for, by two roof gardens, where they may spend a portion of the mid-day interval, and at times hold receptions of their friends. A large concert hall, seating 1,500 people, has also been erected. In this hall concerts and dramatic performances are given, and an amateur dramatic society, a choral society, and a brass band, all draw their members from the employees of the firm.

The following paper will take up the hindrances which have heretofore existed to the development of the best efficiency in British industry, and a suggested modification of the bonus system which, it is believed, will be of great advantage.

* The National Cash Register Co. has been involved recently in a dispute with its employees, but the dispute is reported to have been settled upon mutually satisfactory terms.

POWER AND PUMPING STATIONS OF THE NEW ORLEANS DRAINAGE SYSTEM.

By William Mayo Venable.

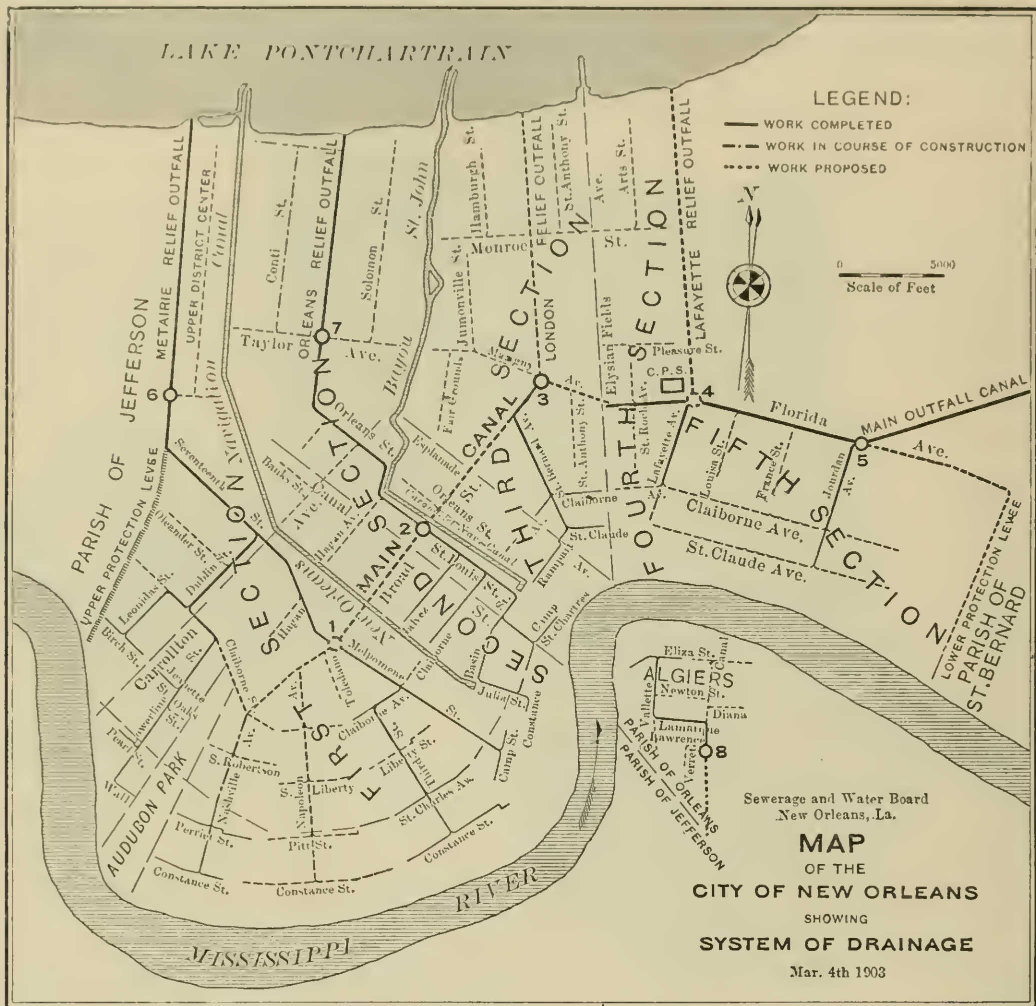
The installations described by Mr. Venable are interesting not only in themselves and in the examples of practice and apparatus they embody, but further than that in the instance they afford of the co-operation of several branches of the engineering profession to accomplish a single result. In New Orleans, as in some of the cities of the Low Countries of Europe, the civil and the municipal engineer have had to call in their mechanical and electrical brethren to provide the solution of the problems of city drainage. In this light the system is especially noteworthy and instructive.—THE EDITORS.

THE city of New Orleans, like most of the land at each side of the Mississippi River in the alluvial country, lies considerably below the high-water line of the Mississippi River. The whole city would be inundated by the river occasionally if it were not protected by a levee along the river front. The city is also protected by levees running at right angles to the river, one above the city and one below it, and also by a levee along the shore of Lake Pontchartrain and by levees along the banks of the various canals which reach from that lake into the territory of the municipality. New Orleans is so near to the mouth of the river that the land upon which the city is built is not only lower than the high-water stage of the river, but is in part lower than the level of the Gulf of Mexico and of the various lakes in the vicinity of the city. Therefore there is no natural drainage for the land enclosed by the levees surrounding the town. The rain water that falls upon this area has to be pumped, so as to force it to flow into either Lake Pontchartrain or Lake Borgne. The city itself covers a large area, although the major part of its area is not built up as a city. The part at present chiefly occupied by buildings consists of a strip a mile or so wide along the bank of the river.

It has long been recognized as extremely desirable to drain properly all parts of the city between the river and Lake Pontchartrain and this work was actually undertaken some years ago, and four and one-half million dollars have been spent upon the drainage system, which is now about half completed. The money available for drainage purposes at the present time has been exhausted and the work will shortly be suspended, and will remain in about its present degree of completeness until additional funds are provided. The area to be drained under this drainage plan consists of about 24,000 acres or 37½ square miles. This area is the subject of rainfalls, the greatest of which for

MAP OF THE LOW LAND.

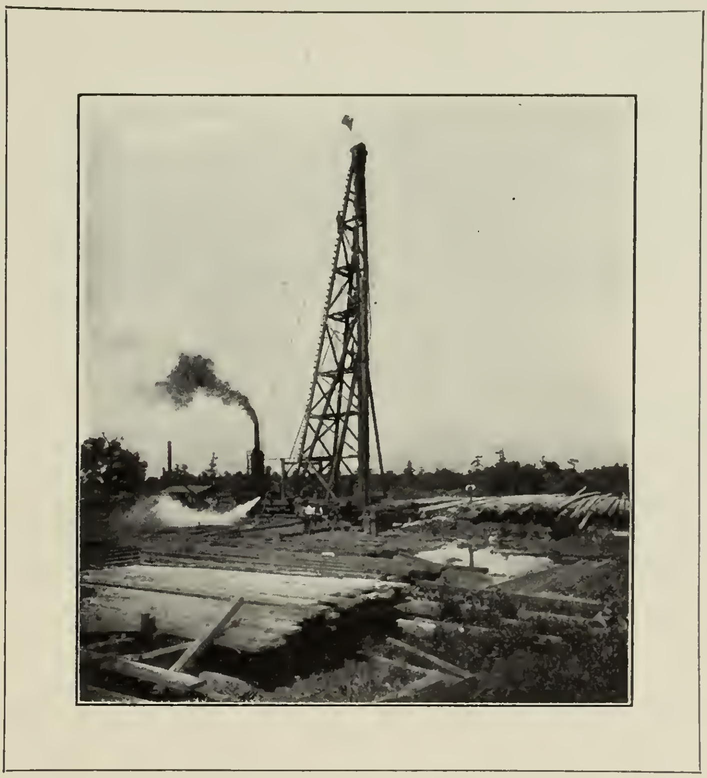
many years has been about 7½ inches within 24 hours, which is equivalent to a cube of water 870 feet long, wide, and deep. Of course, such a rain occurs only at very rare intervals. In 1894, before work on the new drainage system was commenced, records were kept of the amount of rainfall each year, and these records have been continued until the present time. During the month of July, 1894, 325,739,830 cubic feet of water were drained away from about half the total area included in the drainage plan. This discharge for one month is equivalent to a cube of water 685 feet on each edge, or to a lake 10 miles long, 600 feet wide, and 10 feet deep, or to a canal 80 miles long, 40 feet wide and 20 feet deep.



MAP OF CANALS, LEVEES, AND PUMPING STATIONS.

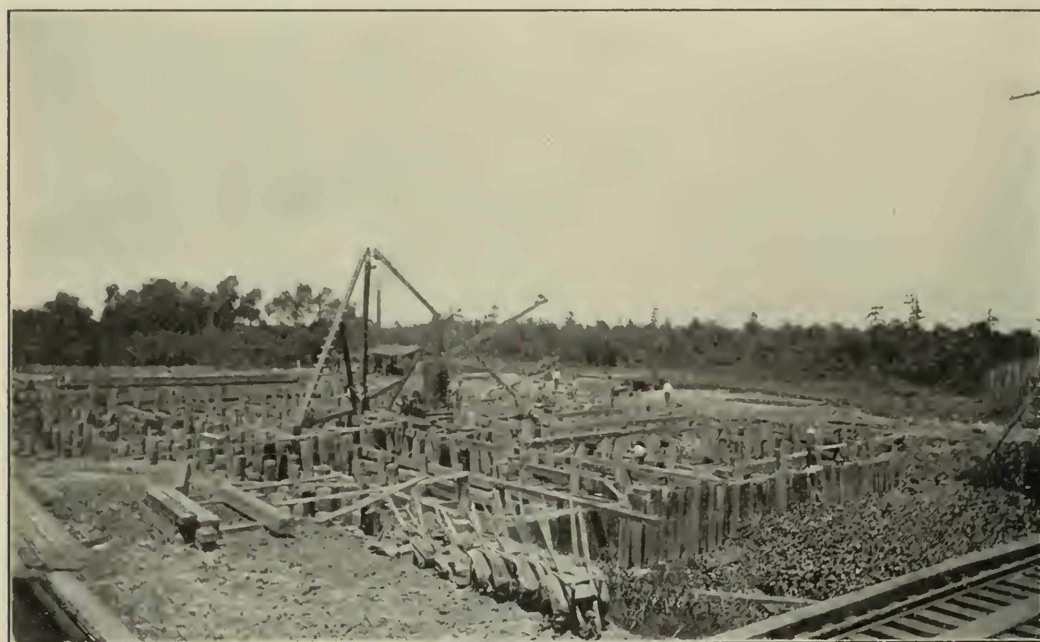
The drainage plan adopted provided for a system of canals for the purpose of collecting the water and conveying it to pumping stations by which it is pumped to the level of either Lake Borgne or Lake Pontchartrain, into which it then flows. The plan provides for a continual removal of seepage water and ordinary daily drainage from the soil and the disposal of all such waters into Lake Borgne. It also provides for the rapid removal of storm water, which is to be pumped partly into Lake Borgne and partly into Lake Pontchartrain. Many of these canals are lined and covered with masonry and entirely concealed from view underneath the surface of the streets. Others are open ditches with sloping earth sides. The engineering features of the canal system proper are extremely interesting, but it is of the pumping stations that the present paper treats.

These pumping stations may be divided into two classes:—those that pump the daily drainage and are intended to operate continuously day and night, and which also are equipped to operate as storm stations in times of flood; and those which operate as storm stations only, it being not the intention to have them handle any polluted water. These storm stations discharge water into Lake Pontchartrain, which is a land-locked lake comparatively shallow, communicating with Lake Borgne and with Mississippi Sound through a comparatively narrow opening known as the Rigolets. This lake as well as Lake Borgne is subject to variations in level, owing to wind storms in the Gulf of Mexico. The range of these variations is 6 or 8 feet.



PILE DRIVER AT WORK, STATION NO. 7.

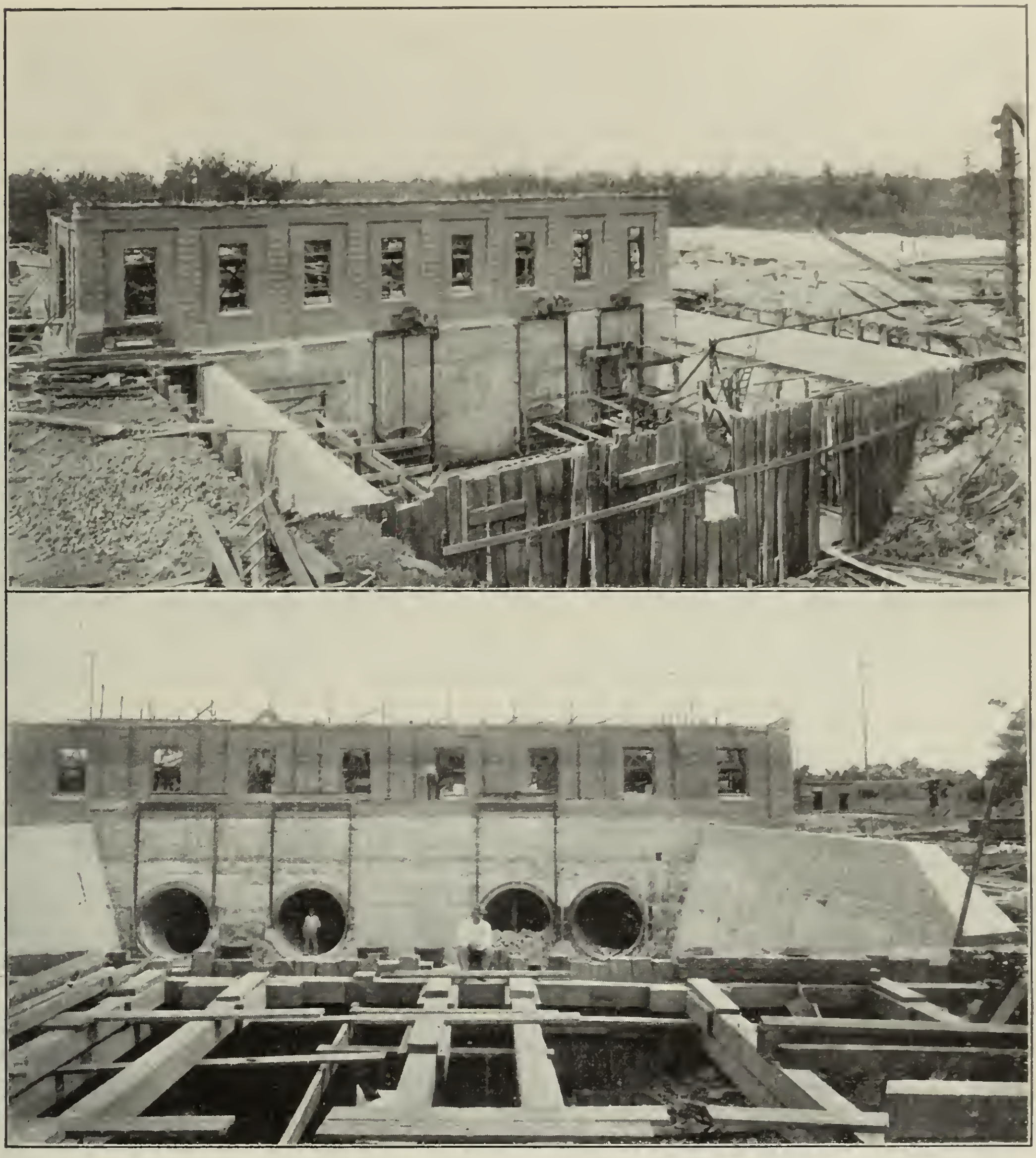
Owing to the very great extent of the work and to the desire of the city to obtain drainage for certain portions before waiting for the completion of the entire system, and before spending the bulk of the money required to build the drainage system, it was decided to build these storm stations first, and to utilize them temporarily for the disposal of all drainage in the city. At the present time the two principal storm stations have been completed, and are in operation. Three of the other stations with constant-duty equipment as well as storm equipment are complete, but the constant-duty equipment is not operating to discharge water into Lake Borgne as ultimately intended, because the canal system leading to Lake Borgne has not been completed and put into operation. It is not improbable, however, that small canals



THE PILE-DRIVEN FOUNDATIONS FOR PUMPING STATION NO. 7 APPROACHING COMPLETION.

at present existing will be utilized to discharge the daily flow into Lake Borgne before work is wholly suspended upon the system during the current year.

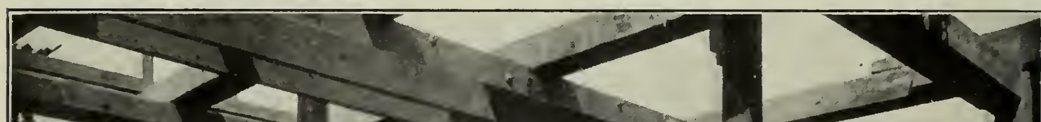
The first to be built and the most important of the storm stations, owing to the fact that it is relied upon to pump the water from the drainage area in the business part of the town, is known as pumping station No. 7. The land in which this station is located is a foot or so below lake level and the station pumps the water from the canals leading to it into a canal leading into Lake Pontchartrain. This outfall canal is provided with levees to prevent the water from overflowing the surrounding country. This pumping station and all others are built upon substantial yellow-pine piling 60 feet or more in length, driven over the entire area occupied by the pumping station and the suction and discharge basins connecting with it. Pumping station No. 7 itself was built directly across an old canal, the water of which was diverted by means of a temporary by-pass. After the piling was all driven (including sheet piling around all of the founda-



STATION NO. 7 DURING CONSTRUCTION. THE UPPER VIEW SHOWS THE SUCTION BASIN; THE LOWER, THE DISCHARGE BASIN.

tion walls) the space between the piles was excavated, the piles cut off at proper elevation, and covered with capping and decking upon which the masonry work was erected. Pumping station No. 7 and pumping station No. 6, which is almost like it, contain submerged centrifugal pumps. It was necessary therefore to make deep excavations, about 25 feet from the surface of the ground. This is difficult in any soil such as exists in New Orleans, especially in the lower parts of the city where the soil is thoroughly saturated with moisture, and where the soil is chiefly Mississippi River sand, a material more like a mixture of silt and ooze than sand, for it is extremely unstable under very slight degrees of pressure. The

DISCHARGE PIPES BEING PLACED AT PUMPING STATION NO. 6. SHOWING THE CONSTRUCTION OF THE FOUNDATIONS.



SUCTION PIPES BEING PLACED AT PUMPING STATION NO. 6.

foundations having been laid, large boiler-iron pipes leading to and from the points at which the large pumps were to be located were installed and the masonry work of the station, including the suction and discharge basins, was completed up to the floor line, and the superstructure of the building properly completed. The pumps themselves and the machinery were installed after the building was under roof.

TRAIN LOAD OF PUMPS FOR PUMPING STATION NO. 7.

All of the pumping stations and the central power house are built of pressed brick and are of similar appearance. The roofs are of slate with tiling at the corners. The cornice work is of galvanized iron, the roof trusses of steel, and the floors of cement. There are three pumps at pumping station No. 7, with a pit for a fourth pump which has not been installed. These three pumps are all alike, and each one has the capacity to throw 250 cubic feet of water per second to a height of 10 feet when operating at normal speed. For lower lifts the quantity of water thrown is much greater, running up as high as 350 cubic feet at small heads. The maximum height to which they are expected to operate is 12 or 13 feet. The pumps are of the centrifugal type, and each pump is driven by a vertical shaft, to the top of which is attached a synchronous three-phase electric motor of 350 kilowatts capacity. These motors have stationary high-potential armatures, which take current direct from the line at 3,150 volts. The moving portion or fields take current at 125 volts, which is supplied by rotary converter in connection with step-down transformers. One set of lines from the central power house is capable of operating motor and rotary. The weight of the shaft and the field of the motor is carried on vertical thrust bearings which consist of several plates

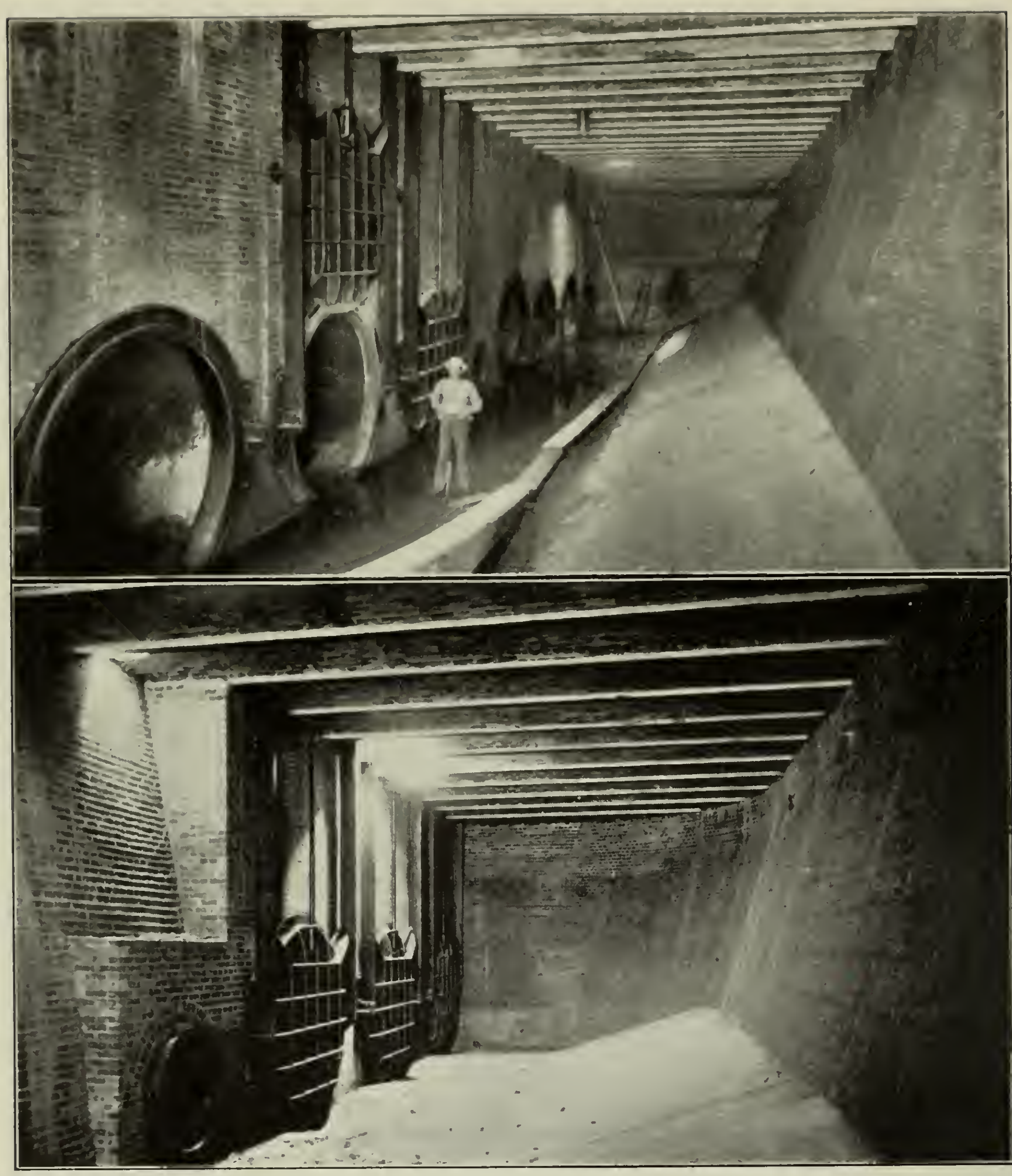
INTERIOR OF PUMPING STATION NO. 6.

alternately of brass and of iron which turn upon one another. These plates were ground to a fit by the use of sapolio after the pump was installed. These plates run in oil and rest upon a bearing which is water-jacketed to prevent overheating. Some trouble was experienced with these bearings when they were first installed, but after the bearings had been worn to a nice fit they caused no further trouble. As is well-known to all electrical engineers, the difficulties with synchronous motors are the difficulty of starting them and the comparatively small overload which they will carry without danger of their going out of step. There are two methods by which the pumps at station No. 7 can be started, but only one of these methods is actually used. The method which is not used is to pump out the pit in which the pump is set, so that the pump can be started without any load, then to start the motor as an induction motor, and to throw into synchronism when it comes to speed. The load can then be put on by opening the station gates. This method is very slow on account of the necessity of pumping out the pits before starting the large pumps. The method that is actually employed is to use an engine at the central power house for the purpose of starting up any motor and to start the engine and the motor together, the motor coming up to speed under load at the same time as the engine. This method works admirably and it is perfectly practicable to start up as many pumps as may be desired at one time by this method. The pumps may be stopped by the closing down of the gates and the simple opening of the switch on

EXTERIOR OF PUMPING STATION NO. 6 DURING TEST OF THE CAPACITY OF THE PUMPS.

the electric motor without affecting the running of any other motor. There is no difficulty with the motors going out of step on the pumps at station No 6 and station No. 7, as the load is practically a steady one, and as the motors have a very great overload capacity.

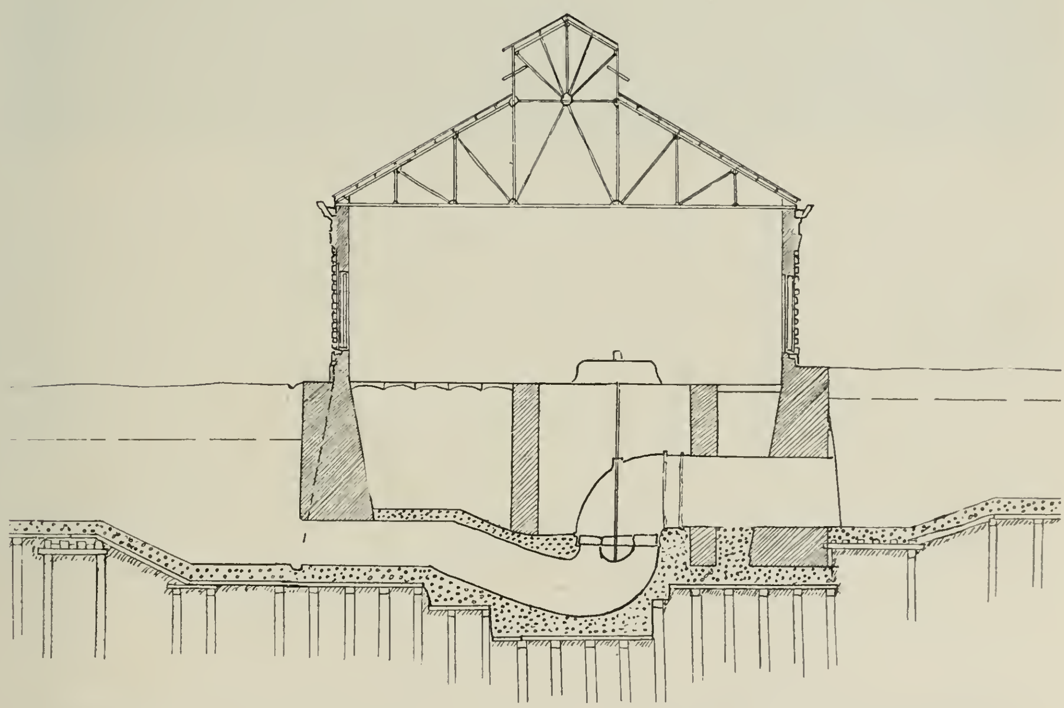
The gates for controlling the water at station No. 7 are of cast iron, strongly ribbed. They slide in special channels and are raised or



SUCTION AND DISCHARGE BASINS, STATION NO. 3.

The suction basin is shown in the upper view, the discharge basin in the lower one.

lowered by means of screws which are operated by electric motors. It has been found in practice that a flap gate on the discharge side of the station is very much to be preferred to the type of gate originally installed, and accordingly flap gates are to be installed on the discharge side of the station in addition to the existing gates. This will make it possible to start up and stop any pump without any attention being paid to the opening or closing of gates. The old gates can be left open at all times, except when it is desired to close them for the purpose of making repairs. This station and its sister station, No. 6, together, with their present equipments, are capable of pumping 1,500 cubic feet of water per second, a height of 10 feet, or 2,000 cubic feet of water per second, a height of 6 feet or less. They therefore provide for the disposal of about 2,000 cubic feet of water into Lake Pontchartrain under the conditions of exceptional storms. Pumping station No. 3 is capable of discharging about 650 cubic feet into the lake under storm conditions, making the total capacity of the drainage system with its present equipment about 2,600 cubic feet per second pumped into the lake under the conditions of exceptional storms, during which the water in all the canals is very high. This will shortly be increased 300 cubic feet by the installation of another pump at station No. 6. 2,600 cubic feet per second is equivalent to a stream of water 10 feet deep and 44 feet wide, flowing at the rate of 4 miles an hour, or the average velocity of the Ohio River, or the rate of an easy walk.



SECTION OF PUMPING STATION NO. 1, SHOWING ARRANGEMENT OF THE WATERWAYS.

The upper (solid) line on both sides indicates the surface of the ground; the lower (broken) line indicates the water level.

Pumping stations Nos. 6 and 7 take their water partly from a territory which is tributary to them without any other pumping and partly from the outfall canals leading to pumping stations Nos. 1 and 2. These two pumping stations are arranged to pump storm water in two directions, first in the direction of the main canal running ap-

SITE OF PUMPING STATION NO. 6, SHOWING BY-PASS, PILE DRIVER, AND OLD CANAL FILLED WITH WATER HYACINTHS.

proximately parallel to the river and eventually discharging into Lake Borgne, and second into relief canals running to stations Nos. 6 and 7, and thence into Lake Pontchartrain. The intention is to pump all of the light storm water to Lake Borgne and to utilize the canals leading to stations Nos. 6 and 7 only for the surplus water in times of heavy storms, which cannot readily be disposed of into Lake Borgne. In pumping stations Nos. 1 and 2 machinery has been installed leading only in the direction of Lake Pontchartrain, and up to the present time no water is pumped along the line of the main canal. At these two stations, however, there have been installed constant-duty pumps as well as storm pumps. These constant-duty pumps discharge in the direction of Lake Pontchartrain, but it is the intention to change the direction of their discharge and pump the water into Lake Borgne as soon as practicable to do so; therefore at the present time the constant-duty pumps are very little used, there being no constant-duty pumps at stations Nos. 6 and 7.

The constant-duty pumps at these two stations are of the submerged centrifugal type operated by synchronous motors similar to the large pumps at station No. 7, but of much less capacity. Each pump has a capacity for lifting water 10 feet or less. The storm pumps at these stations are of the screw type, each capable of pumping 250 cubic feet of water per second a total height of 5 feet; this is sufficient for the purpose of these auxiliary stations, which do not discharge water direct into the lakes, but serve merely to facilitate the flow.

The characteristics of screw pumps are quite different from those of centrifugal pumps. The centrifugal pump takes the greatest load when operating at low heads, while the screw pump takes considerable less load while operating at low head. The screw pumps are more efficient than the centrifugal pumps when operating at exactly the head for which they are designed, but they will not operate as satisfactorily as the centrifugal pumps for excessive heads.

During exceptional storms under present conditions with the water all being pumped into Lake Pontchartrain, the present pumping equipment at stations Nos. 6 and 7 is not sufficiently great to enable the pumps to keep the water down to the proper flood slope in the canals, and in consequence the water rises on the suction side of the station, so as to be pumped only 6 or 8 feet instead of 10 or 12 feet. The result is that these stations throw a considerable excess in quantity of water, and they also take a considerable excess of power over what they would take when operating at normal head. Under these conditions, that is, when the amount of water exceeds the capacity of the pumps, the auxiliary stations Nos. 1 and 2 are of little use, and in fact during such storms there is nothing gained by operating these stations at the present time. During light storms, however, they serve to remove the water rapidly from the densely populated portions of the city. When the entire system is completed, instead of fulfilling a secondary purpose these stations will be of primary importance, and stations Nos. 6 and 7 in all probability will be operated comparatively seldom.

The two pumping stations Nos. 1 and 2 are exactly alike in general appearance, and very similar in arrangement. The general features of the machinery are identical, but it was found by experience at station No. 2, which was built first, that great improvement could be made in the arrangement of the watercourses, and in consequence the arrangement of the pits leading water to the pumps at station No. 1 was very materially changed from the present arrangement at station No. 2, and it is highly desirable that the pits at station No. 2 shall be changed to correspond with the arrangement of the pits at station No. 1.

INTERIOR OF PUMPING STATION NO. 3. THE UPPER ENGRAVING SHOWS THE GENERAL VIEW. THE LOWER SHOWS THE ELECTRICAL CONNECTIONS BEHIND THE SWITCHBOARD, ALSO THE ROTARY AND TRANSFORMERS; CONSTANT-DUTY PUMP ON THE LEFT.

The gates at station No. 2 are similar in principle to those at stations Nos. 6 and 7, but at station No. 1 flap gates have been installed These gates are kept from closing suddenly by large dash-pots or controllers similar in principle to the small dash-pots often placed on doors. The dash-pots are filled with water and the rapidity of the closing of the gates depends upon the size of an opening connecting one side of the piston with the other. These two sides of the piston are joined together by a pipe in which is placed a controlling valve to regulate the rapidity of the motion.

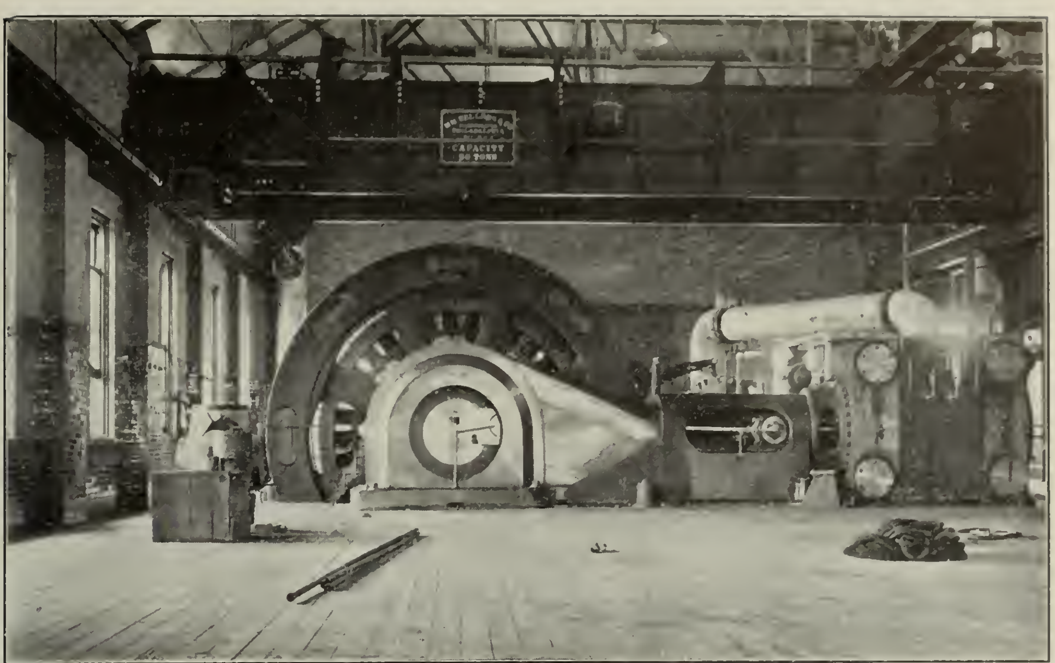
Pumping stations Nos. 1 and 2 are operated in the same manner as stations Nos. 6 and 7. The process is exceedingly simple, and is as follows: Whenever it is desired to start any pump or any set of pumps, the station attendant calls up the central power house over the telephone, and notifies the power house to furnish current. He then closes the switches on his switchboard connecting the rotary converter and the pumps which he wishes to start with the proper line. The engineer at central station starts up his engine and brings it up to a certain speed. He then slacks the speed a trifle and while he is slacking the speed the attendant at the pumping station closes a switch which turns into the fields of the synchronous motors, thus putting them in step with the generator at central station. The engineer at central station is informed of the fact the moment the motors are in step by looking on his electrical instrument, and he then increases the speed of his engine to the normal speed. He is then able to continue to run these motors on that engine or to transfer the load to any other engine or any combination of engines without any difficulty or complication, and without shutting down. By this method it is possible to start up any number of pumps at the same time with very great economy and without any undue strain on any part of the equipment, either electrical or mechanical.

The four pumping stations which have been described are all equipped with submerged pumps. Another pumping station, station No. 3, has recently been completed, in which all of the pumps stand above the floor line. Pumping station No. 3 is arranged to discharge water either direct into an outfall leading to Lake Pontchartrain, or along the main canal leading to Lake Borgne. The present equipment discharges into Lake Pontchartrain only, and contains two pumps of 250 cubic feet per second capacity each, with a lift of 8 feet, and one constant-duty pump with a lift of 16 feet. These pumps are all of the same general design. They are operated by synchronous electric motors on horizontal shafts direct-connected to the runners of the pumps. To start these pumps the motors are brought up to speed while the pumps contain no water. This is done by starting the generator and the pump at the same time. It is necessary to prime the pumps by pumping the air out of the pumps and the penstocks, so that the water will rise and fill the pumps. The pumps are put out of service merely by allowing air to enter them, or by slowing down and allowing air to enter. For a station arranged as this is no gates are necessary, as the pumping apparatus is above water level, and all that is necessary to prevent water from flowing through the station is to break the vacuum. There is an objection to having the constant-duty pump above the floor line, however, which is that this pump is intended

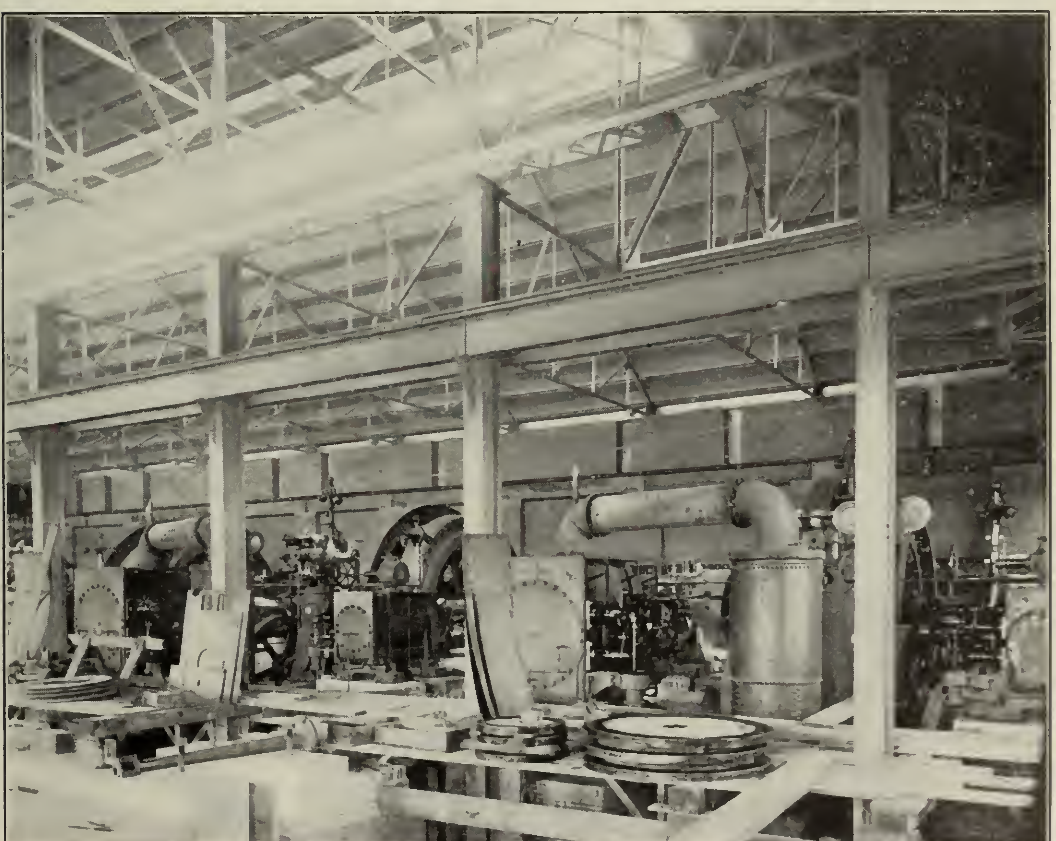
FRONT VIEW OF CENTRAL POWER HOUSE, IN COURSE OF ERECTION.

to keep the canals pumped almost dry during ordinary weather, and that as a pump above the floor line thus implies a very considerable syphonic action in the suction and discharge pipes, it is difficult to maintain the necessary vacuum with water at comparatively high temperature such as exists in the drainage canals in the summer time.

The general design of the drainage system provided for the water being pumped successively at the various stations Nos. 1, 2, 3, 4, and 5, at the last named of which it passes into an outfall canal leading to Lake Borgne. At each pumping station the volume of water is increased by that which flows in from the section in which the pumping



THE LARGEST ENGINE AND GENERATOR IN THE POWER STATION.



MACHINERY ROOM, CENTRAL POWER HOUSE, BEFORE THE PLACING OF THE FLOOR.

INTERIOR OF ST. LOUIS CANAL. (COVER NOT QUITE COMPLETE.)

station is located, so that each successive station has a larger equipment than the one preceding it. At the present time stations Nos. 4 and 5 have not been built owing to lack of funds, and the main canal connecting these various stations has not been built, except near where station No. 5 will ultimately be constructed. There is, however, an old but small canal along the line of this main canal which is not now used except as a branch canal to collect local drainage. The relative merits of the different pumping stations that have been built will afford valuable information concerning the construction of the two pumping stations to be built in the future, and as the work of building these stations will probably be postponed for a number of years, there will be ample opportunity for working out the problem so as to utilize every available advantage.

To operate these various pumping stations, a central electric power house has been constructed with ample floor space for installing all of the machinery that will be necessary to complete all of the future installation, but with the present installation of machinery sufficient only to operate the pumps that have already been installed. The station is divided into two parts, the boiler room and the machinery room, the boiler room being in the rear and the machinery room in front. The boiler room is arranged to have all of the boilers in one row. Suitable arrangements for bringing in coal have been provided, and all of the existing boilers are provided with mechanical stokers. The engine room is divided into two portions, in one of which was placed the first machinery installed, while the second affords room for future machinery. At present there are installed a number of engines and generators varying in capacity from 100 horse power to 1,500 horse power. Each of these units can be operated separately and connected to any individual pump in the drainage system, or any number of these units can be operated in multiple and connected in multiple to any number of pumping units. The generators are three-phase synchronous machines. The vacuum of the steam exhaust is not as low as is frequently obtained in northern cities, owing to the temperature of the water used for cooling. This water is taken from an open canal which circulates around the power house, and which is exposed to the action of the rays of the sun during the entire day. No better source of water is at present available for this purpose.

From the central station two sets of feeder lines run to each station, upon either one of which the station can be operated, but both feeder lines are used under ordinary conditions. The pole line which carries these feeders also carries a private telephone circuit. The various stations also have communication with the telephone exchange of the city, and central station has a private line to the office of the general manager of the operating department in the city hall.

This is one of the most important, unique, and instructive electrical plants in the United States. The purpose for which the current is used and the peculiar conditions necessary to perform the drainage of this city properly are unparallelled among the applications of electric-power transmission. The drainage problem itself is of very great difficulty and of great interest, and a certain amount of experimentation has been unavoidable in the past, while future additions to the system, in order to be made properly, must be based upon a careful scientific study of the behavior of what has already been built.

GREAT ELECTRIC INSTALLATIONS OF ITALY.

By Enrico Bignami.

THE HYDRO-ELECTRIC STATION OF CENISCHIA.

The power station described by Signor Bignami is interesting as an example of the use of very high-head water power in connection with long-distance electric transmission practice which is finding its most striking expression on the Pacific Coast of North America, while huge possibilities are open in the Scottish Highlands. It is interesting further in that it shows the export opportunities in engineering. This Italian station represents the skill and the industrial energy of American, English, German, and Swiss engineers and manufacturers.—The Editors.

AMONG the many Italian water powers, the installation of Cenischia, now under construction by the "Societa delle Forze Idrauliche del Moncenisio" (an incorporated company with a capitalisation of 4,000,000 lire) in the plain of the Novalesa near Susa, is of particular interest on account of its wide differences from preceding undertakings.

The Cenischia torrent, a tributary on the left of the Dora Riparia, rises on the slopes of the chain of Alps extending from the Bard glacier to the Lamet glacier—a chain which spreads like a vast ampitheatre, crowning with its peaks the wide plateau of Cenisio (Mont Cenis) in which lies the lake of the same name. The area of the basin is about 80 square kilometres; that of the lake of Cenis (which acts to some extent as a regulating reservoir for the outflow) is 2,000 hectares. The altitude is 1,910 metres, or about 6,250 feet above sea. The outlet of the lake is the Cenischia, a stream of very variable volume. Impetuous as a torrent in the season of melting of the snows, it maintains almost a constant flow during the summer, falling to a minimum in the month of February. This minimum flow is calculated at 800 litres a second, corresponding closely to 10 litres per square kilometre of watershed. About one kilometre below its exit from the lake the stream reaches the exit from the high valley of its source; near Gran Croce it receives as tributary the outlet of two other small lakes—Lac Blanche and Lac Noir—and thence follows a course parallel to the great road which Napoleon built over Mont Cenis. At about ordinate 1,720 it turns sharply to the east, skirting the village of Ferrara, and leaping from rock to rock, it reaches

THE BARD CASCADE, NOVALESA.

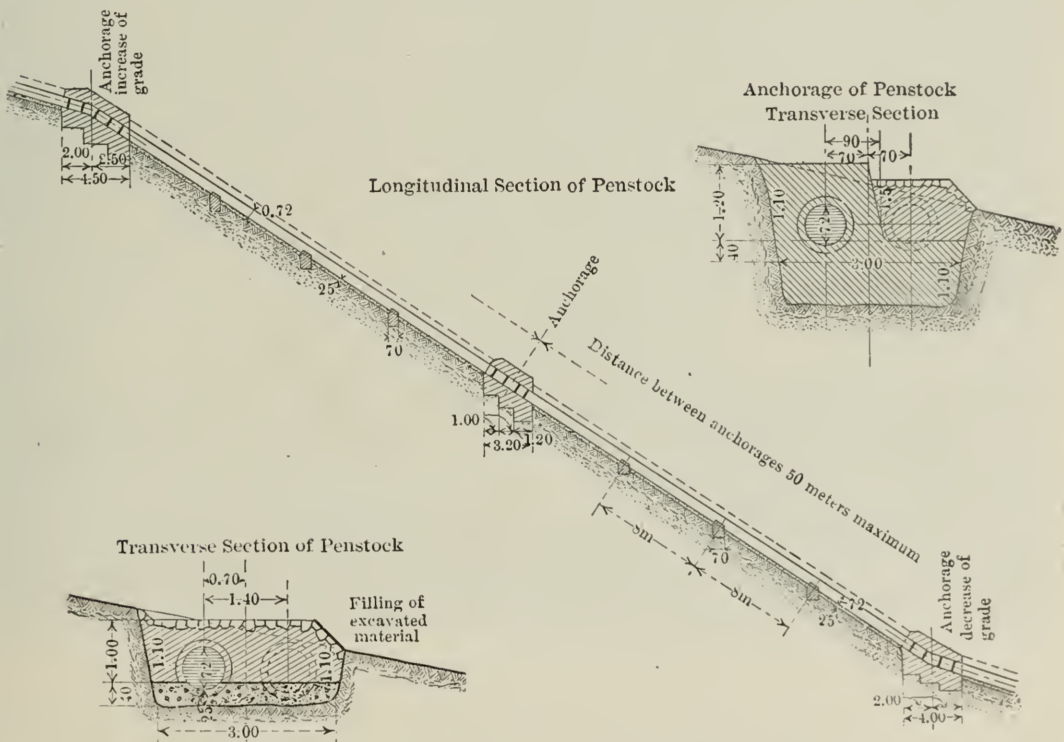
the bottom of the lower valley near to Novalesa, having fallen nearly 900 metres in a course of about 5 kilometres. Beyond Novalesa the valley falls gently, and the Cenischia flows through it smoothly in an ample bed toward its confluence with the Dora Riparia.

The highly favourable conditions thus presented suggested to Italian engineers and to foreign financiers the possibility of developing the water power of the Cenischia, in an installation of large capacity and under most promising economic conditions. The first studies of the "Societá delle Forze Idrauliche del Moncenisio" were directed toward the utilisation of the whole of the available power by two stations, dividing the fall into two parts—the first of 415.19

THE CLARETTA FALL, NEAR NOVALESA.

metres, from ordinate 1,707.49 to ordinate 1,292.30, and the second of 433.70 metres, from ordinate 1,292.30 to ordinate 848.60. There is now under discussion a variant of these plans, by which a single fall of 859 metres would be utilised. The project is completed by the regulation of the regimen of the lake so as to make of it a storage reservoir for providing a constant flow of 1,020 litres, which may possibly be raised to 1,400 litres, giving a potential nominal horse power of 16,000. All the work is constructed with a view to the ultimate usage of the 1,400 litres.

Near to the repair station No. 5 on the Mont Cenis road, at a point where a quiet stretch of the Cenischia serves as a sort of settling basin, are the first headworks. They consist of a strong masonry dam, 15 metres long, across the channel of the stream. The intake is on the right bank, where a small reservoir with discharge opening is provided. From the gate house on this reservoir leads a masonry canal, entering at once into tunnel; at about 100 metres distance from the intake is the weir for regulating the volume of flow in the canal. It follows thence the line of the National road, the tunnel of the old Fell Railway, and comes out on the open slope of the mountain. Following along the hillside sometimes in the open and sometimes in tunnel, it reaches the ridge of the spur limiting the watershed of the Bard, where the penstock begins. The length of the flume is 2,500 metres, its breadth 1.00 metre, and its depth 1.35 metres. It is of masonry, laid in cement and carefully pointed, and its open stretches are covered over with stone flags to protect it from ice and landslides—the constant enemies of masonry construction at these altitudes. The work throughout, therefore, is on but a small scale, but every inch of the space it occupies has been wrested, bit by bit, from the mountain side; it exhibits, moreover, the distinctively Alpine character belonging to the region.



SECTION OF PENSTOCK AND ITS ANCHORAGES.

At ordinate 1,707.49 is situated the charging and settling basin and the last weir. As it is the plan of the company to operate at least a part of the plant at the earliest possible date, the lower fall alone will be utilised at first, the upper one being not in penstock but left as an open flume, of the same form as the race above, bringing the water to the intermediate station. This flume is excavated wholly in the rock, and consists of a series of descents and basins, spaced 50 metres apart, with steps and cross-sills intercalated to check the speed of the water and prevent damage by erosion. As already stated, it is 1 by 1.35 metres in section, covered over with flat stones, and with cement-masonry walls most carefully pointed to avoid any loss by leakage. Each litre of flow represents a potential energy of 12 horse power (nominal) at the turbines. The length of this flume is 1,750 metres and the descent is 415.19 metres.

OPEN CANAL, THE PRESENT SUBSTITUTE FOR THE UPPER PENSTOCK.

From the intermediate station, the place of which is taken for the present by a charging basin, descends the penstock of the lower fall, from ordinate 1,292.30 to ordinate 848.60. It is composed of two parallel wrought-iron tubes laid in a cutting and anchored solidly to the ground every 50 metres and at each change of grade, which sometimes exceeds 70 per cent. The pipes composing the tubes are each

5 metres long, 0.72 metres internal diameter, and the metal of the walls has a maximum thickness of 21 millimetres. Every fifth joint—that is, every 25 metres—they are put together with a flanged joint having a rubber gasket 3 centimetres thick. In the lower portion of the penstock, for about one-third of its total length, the pipes are weld-jointed; elsewhere they are made of rings of iron plate lapped and

THE PENSTOCK, AND PART OF THE POWER STATION.

fastened with a double row of rivets. To make them as tight as possible against the very high pressure of the water, all the joints are caulked. The weight of a single tube for the lower fall is about 270,000 kilogrammes and its length 1,060 metres; the working stress of the iron is 10 kilogrammes per square millimetre (14,220 pounds per square inch) allowing 15 per cent. increase over the static pressure for hammer blow. The velocity of the water is 1.72 metres and the volume 0.70 cubic metre per second.

The Novalesa station (next page) contains now three groups of turbo-alternators and later will contain five groups. The upper station will be the same; the entire installation will thus include ten turbo-alternator units. In addition there are now installed at Novalesa two turbine-driven exciting dynamos and four transformers; these

THE NOVALESA POWER STATION.

latter will be eight in number in each of the power stations when completed.

The turbines were furnished by Piccard, Pictet & Co., of Geneva. Each of those intended for driving the alternators is of 1,600 horse power at 500 revolutions with an effective head of 436 metres, and requires 360 litres per second. The wheel is banded with a ring of rolled steel shrunk on. The water is delivered to the turbine through a horizontal cast-steel pipe extending inside the wheel, where it is bifurcated and terminates in two distributors with nozzles of variable section, suggesting in their construction the slide valve of a steam engine. The inner surfaces of the nozzles have graduated curves, so arranged that the direction of the issuing stream remains the same whatever be the position of the opening.

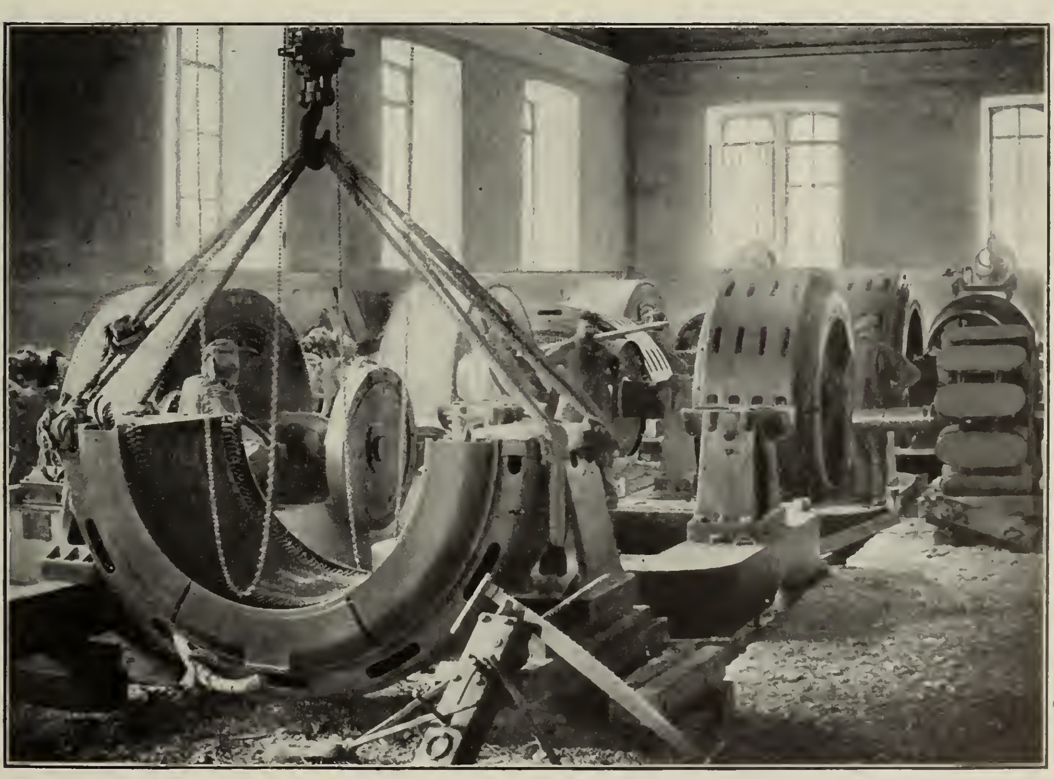
Regulation is effected by a trip-geared auxiliary motor, very simple in construction, so arranged that all parts are readily visible and accessible, and therefore secured against the troubles common to hydraulic regulators when the water is turbid. Hand regulation is also provided. Other features of the construction secure great uniformity of speed, which is of the utmost importance to the parallel working of the several groups. The gates are furnished with by-pass connections.

The turbines for the exciter dynamos are of 110 horse power each at 600 revolutions; they have single distributors.

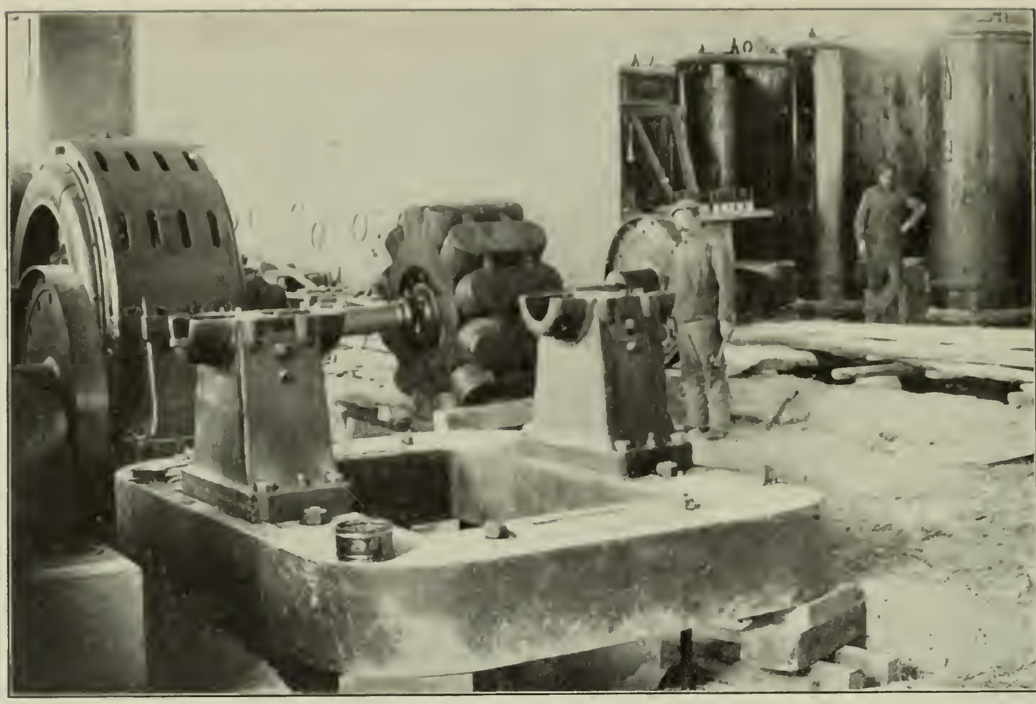
The alternators were furnished by the Thomson-Houston Co. and built by the Union Elektricitäts Gesellschaft, of Berlin. They are three-phase, 1,400-kilowatt machines, each capable of taking the entire power output of one of the 1,600-horse-power turbines, and working with a power factor of cos $\Phi = 0.8$. They have 12 poles and generate current at 3,000 volts, with a frequency of 50 periods per second. They are direct-connected to the turbines by Passard joints. The alternators require 12.3 kilowatts at 125 volts for their excitation, when cos $\Phi = 0.8$. The total weight of each is about 35,000 kilogrammes, the moment of inertia of the revolving part 12,600 kilogrammes, the peripheral speed of the revolving part 42 metres per second, and the efficiency at full load, with cos $\Phi = 0.8$, 95 per cent.

The exciters are by the same makers, compounded, four-pole, each of 75 kilowatts at 125 volts.

The transformers, furnished by the Thomson-Houston Co., are the product of the General Electric Co., of New York. They are single-phase, three of them being star-connected and the fourth held in reserve; by a proper arrangement of switches the fourth may be substituted for any one of the other three. Each transformer is of 1,100

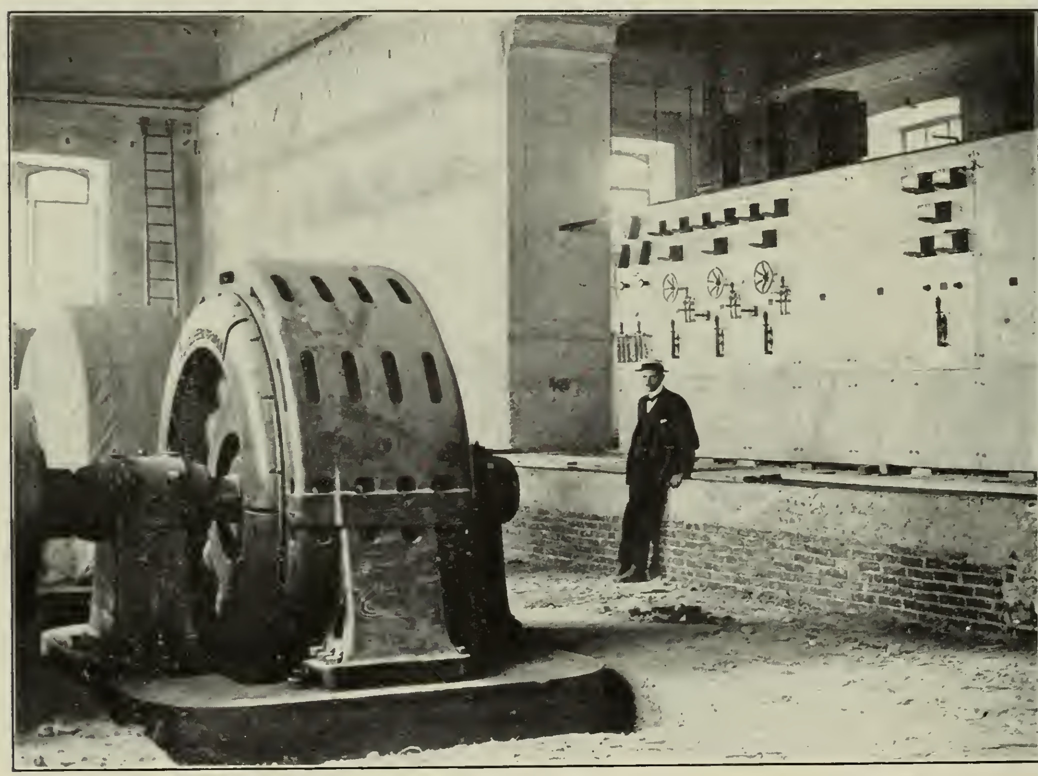


PARTLY ERECTED ALTERNATORS IN THE NOVALESA STATION.



INTERIOR OF THE POWER STATION AND TRANSFORMER ROOM DURING CONSTRUCTION.

kilowatts capacity, placed in oil and cooled with water circulation provided by two small motor pumps run by the exciting machines. The transformers raise the pressure from 3,000 to 30,000 volts, and at



DYNAMO ROOM WITH SWITCHBOARD IN COURSE OF ERECTION.

full load have an efficiency of 98.3 per cent. with cos $\Phi = 1$, and of 97.3 per cent. with cos $\Phi = 0.75$.

There is a special distributing switchboard, all the apparatus subject to high-potential current—such as the oil switches and circuit breakers, the bus bars, fuses, etc.—being removed entirely from the operating switchboard and mounted entirely separate. All the cables

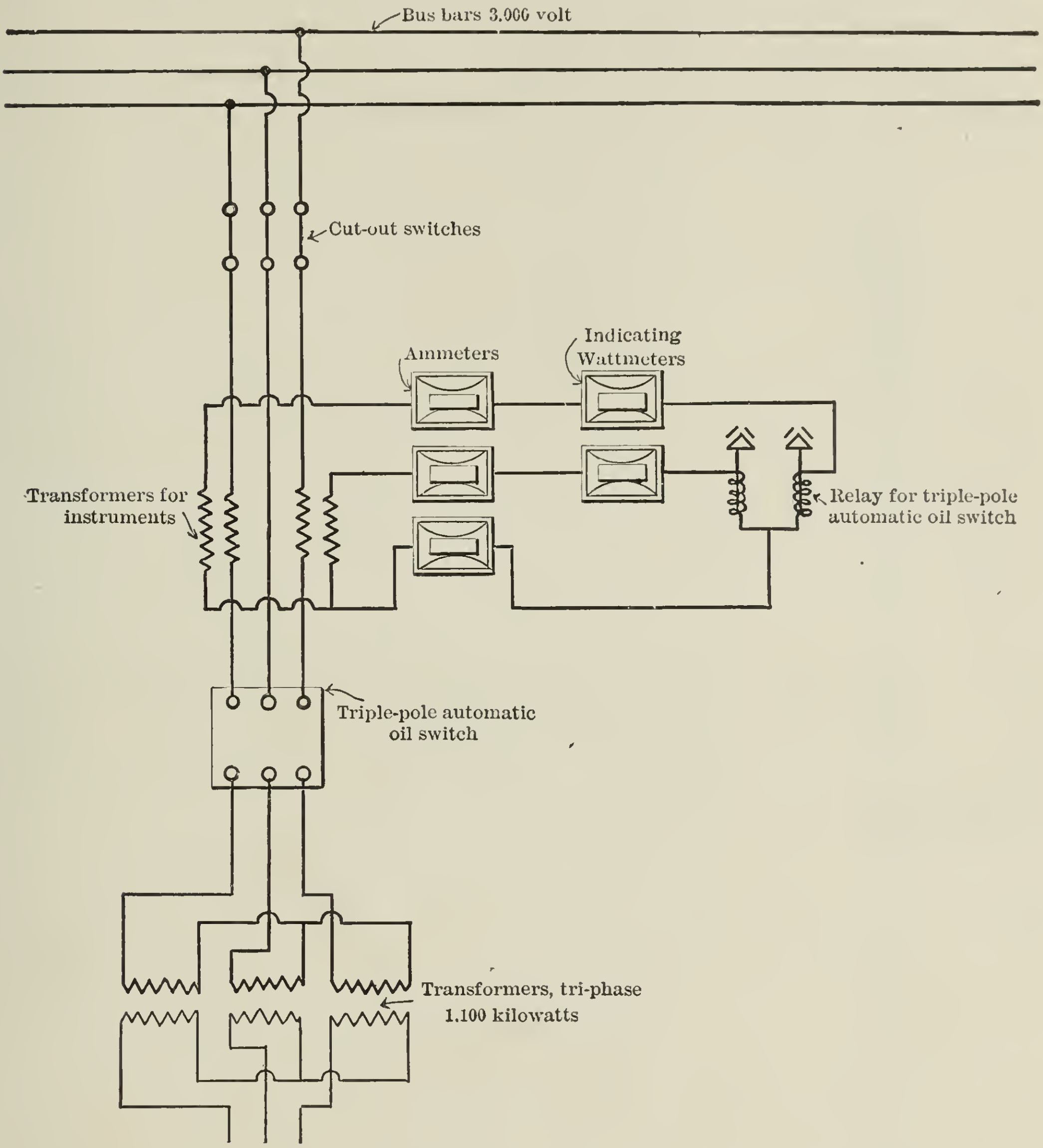
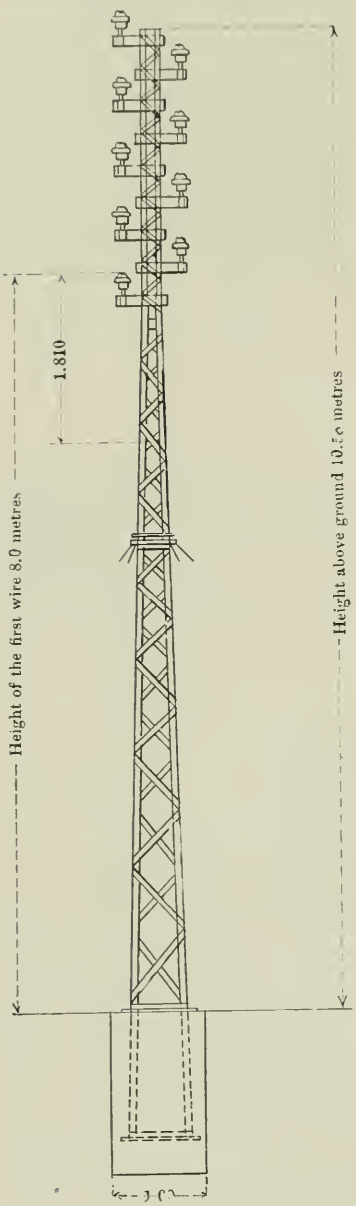


DIAGRAM OF CONNECTIONS OF THE MEASURING INSTRUMENTS AND TRANSFORMERS.

are heavily rubber-insulated and mounted on porcelain insulators. The operating switchboard contains one panel for the two exciters, five panels for the five generators, and two panels for the feeders of the two transformer groups. On the generator panel the apparatus is simply the ampere meter for alternating current, the ampere meter for the exciter current, and the volt meter which serves also for synchronisation. On each of the transformer-cable panels there are three ampere meters, to measure each phase, and two indicating watt meters whose readings are to be added.

A corridor below the dynamo room contains the cables from the alternators to the distributing switchboard, the circuit breaker for 300 amperes at 3,000 volts, and the transformers for the three-phase current. The circuit breakers are placed just where the cables come out of the foundations of the generators, and are separated by partitions and also so placed that no damage to the cables could result from the flame due to the fusion of one of them. In a room below that containing the operating switchboard are placed the three-pole oil switches for the 3,000-volt circuits; they are operated by handles and levers from the board above. These oil-break switches are set in small alcoves in the masonry, which are covered over with marble slabs; across these pass the cables to the 3,000-volt bus bars. There are five of these circuit breakers for the five three-phase generators (300 amperes at 3,000 volts) and two of 750 amperes at 3,000 volts for the two 1,100-kilowatt transformer groups raising the potential to 30,000 volts. These latter are automatic. In all, the current is broken at two points in series for each phase, and the break is effected under oil, contained in a vessel enclosing the whole apparatus.

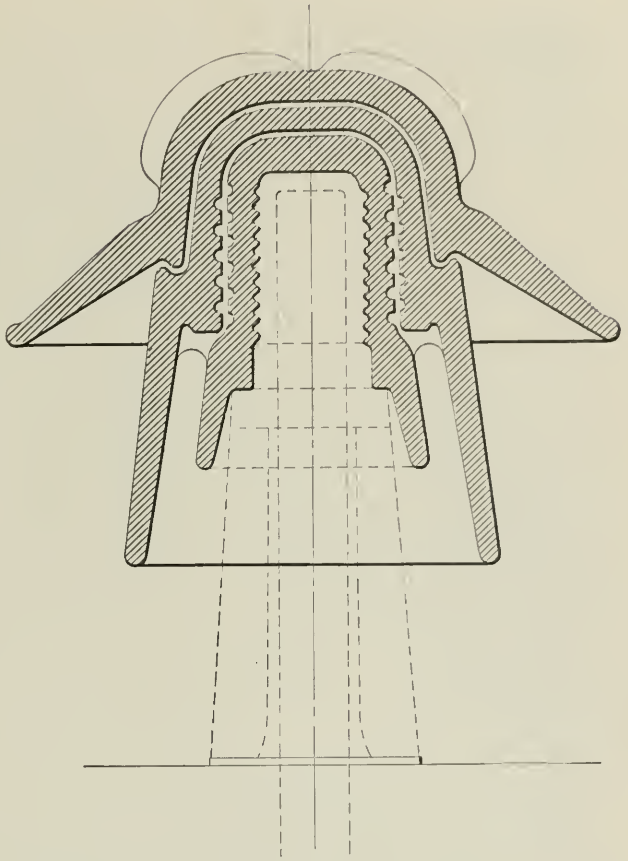


POLE OF THE TRANSMISSION LINE.

An interesting novelty in this switchboard is the arrangement by which the three ampere meters for the three phases of a circuit are supplied with current by two transformers, which also supply the automatic cut-outs and the indicating watt meters.

Wirt lightning arresters are used, made in 200-volt sections, each consisting of five small brass cylinders and two carbon rods The number of sections placed in series used for the protection of any one circuit depends on the voltage of that line.

At the Novalesa station the lightning-arrester sections are placed in two rows on wooden framework carried on opposite sides of a wall, and are separted from one another by partitions.



TRIPLE-PETTICOATED INSULATOR OF THE TRANSMISSION LINE.

The transmission line from Novalesa to Turin—about 61 kilometres—is now under construction. It is carried on iron poles furnished by the "Societá Nazionale delle Officine di Savigliano"; these poles have a minimum height of 10.5 metres above ground, and are normally spaced 75 metres apart. For the present the line has six wires of 6.75 millimetres diameter each, being designed for the transmission of 4,200 kilowatts. When the installation is complete three more wires of 9.1 millimetres diameter will be added, providing thus for the transmission of 8,200 kilowatts. The insulators are of a type specially worked out by the company, triple-petticoated, and are carried on wooden arms. The tension of the current delivered is about 27,000 volts. The line is divided into three sections of approximately equal length.

The transformer sub-station at Turin (Borgata Campidoglio) is under construction, the transformers being supplied by the Oerlikon works. They are of 1,000 kilowatts each, three-phase, oil and air-cooled, and step-down the primary tension of 27,000 volts to the secondary of 3,000. Their weight is 11,000 kilogrammes each; the loss of tension for cos $\Phi = 0.75$ is 3¼ per cent.

The work is being energetically pushed, and in very short time the company will be in position to begin the distribution of electric power. It is estimated that the cost per horse power of the completed installation will not exceed 500 francs, and this will allow the company to realise good profits from the sale of power at very moderate prices.

THE DEVELOPMENT AND USE OF THE SMALL ELECTRIC MOTOR.

By Fred M. Kimball.

III.—THE CHOICE OF MOTORS FOR MACHINE SHOP AND FACTORY.

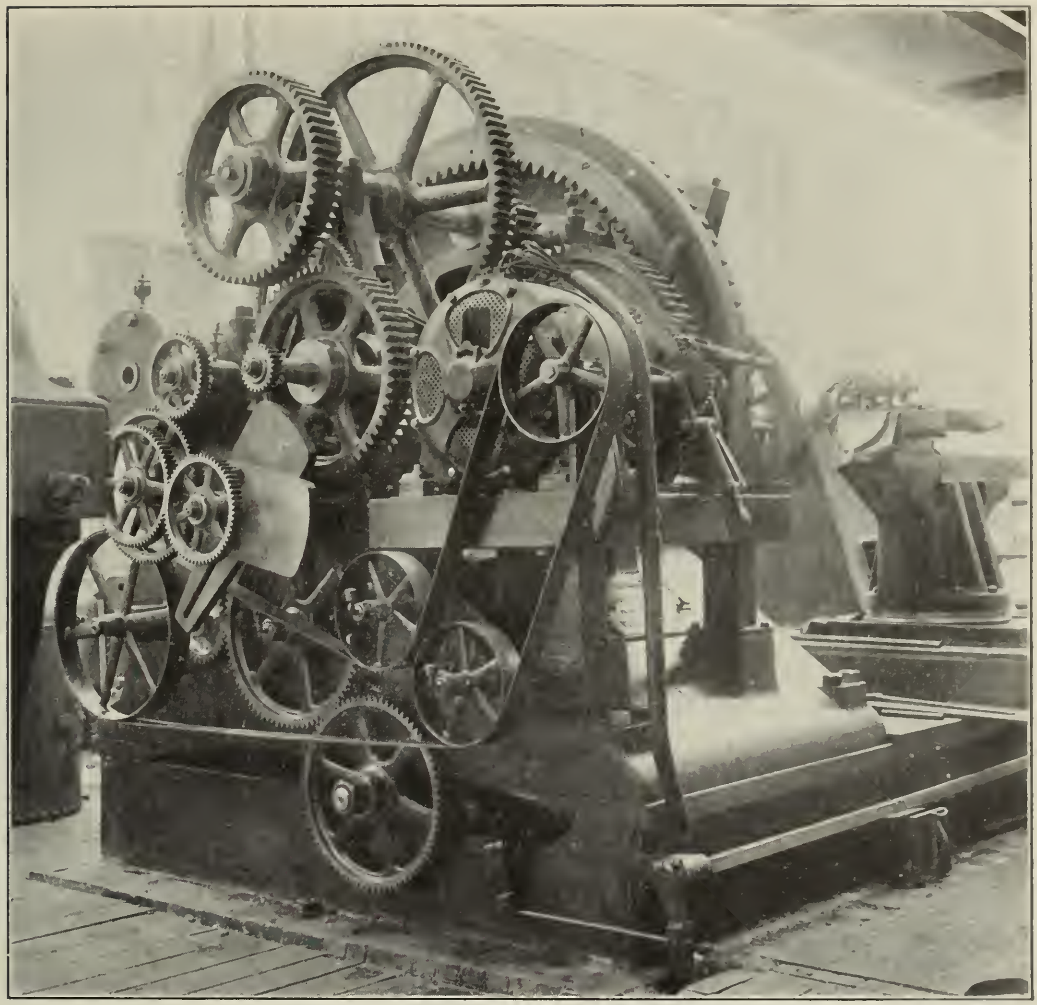
Mr. Kimball's articles, which began in the April number of the Magazine, have already discussed the history and the economy of the electric motor, and its particular adaptation to the machine shop. The preceding article, in May, was especially important by reason of the points it gave concerning the driving of machine tools, and the power required for standard tools and operations. The following number—June—will take up applications of electric driving to a wide range of manufacturing operations.—The Editors.

BEFORE discussing the choice of motors for any given work, let us briefly consider the great general classes into which motors may be divided, and the several types of each class.

In the first class—motors operated from direct-current circuits—we have three principal types; in the order of their development they are: series-wound motors, shunt-wound motors, and compound-wound motors.

The series-wound motor has its armature and fields connected in tandem and the same strength of current passes through all the windings; hence, the conductors in the field spools must be relatively large in cross section and capable of passing as much current as the armature. This motor has no speed regulation worthy of the name, and it is adapted for use only where heavy starting torque is required and where its operation is constantly under the manual control of the operator, or where it is driving a definite and fixed load. It is a very valuable motor within its proper sphere. Practically all railway and automobile motors are series wound, as well as those for crane service.

The shunt-wound motor has its armature connected across the line supply. The field winding is connected in parallel or derived circuit with the armature. In this motor the armature current may be varied without sensibly affecting the field current, and in general the armature current in amperes is very much larger than the field current; hence, the field winding is of relatively small wire. A properly designed shunt motor possesses good inherent speed regulation and a fair starting torque. It is particularly adapted for machines where the load comes on gradually, which are subject to variations without violent fluctuations in power requirements, and where close speed regulation is needed.



122-INCH SELLERS LATHE, SHOPS OF THE WESTINGHOUSE ELECTRIC & MFG. CO., DRIVEN BY 10-HORSE-POWER WESTINGHOUSE ALTERNATING-CURRENT MOTOR.

The compound-wound motor combines in large degree the features of the series motor and the shunt motor. In addition to the fine or shunt winding, another coarse or series winding on the field is added. As usually arranged, the same volume of current circulates in the series field coils, which have comparatively few turns, as circulates in the armature. Generally speaking, these motors do not possess as satisfactory speed regulation as shunt-wound motors, but they possess superior starting torque, and are to be chosen when the power demand is very widely fluctuating and irregular. The greater the degree of compounding the less satisfactory will be the speed regulation. Usually a compounding of from 20 to 25 per cent. will give the best all-around results.

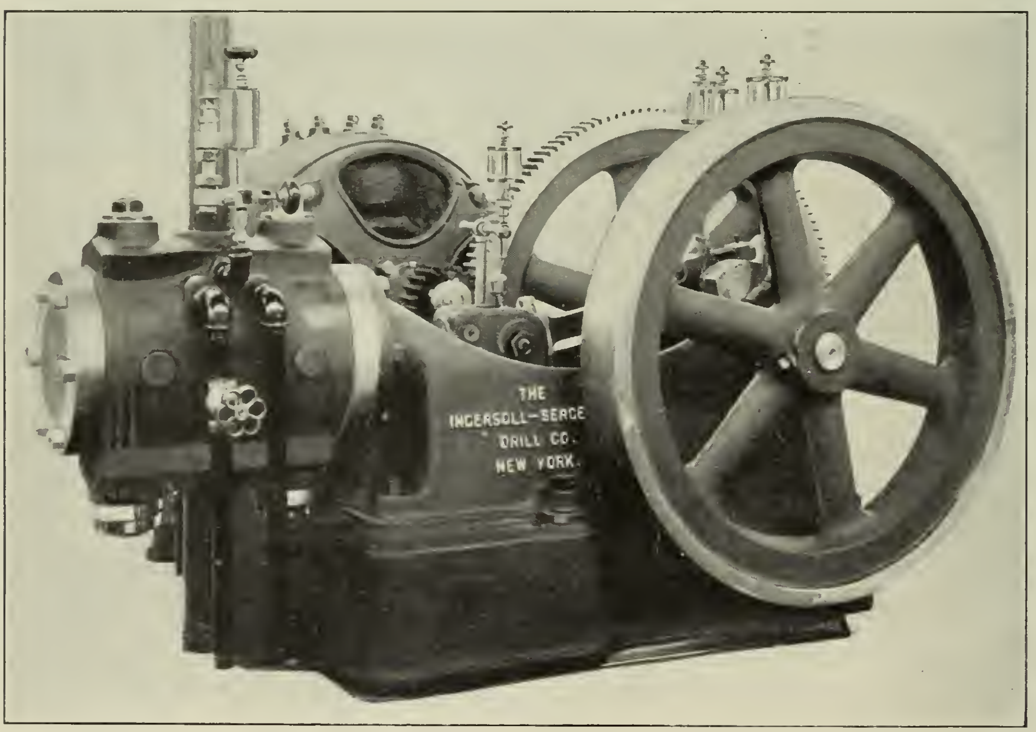
The second class comprises alternating-current motors. These may be single-phase or polyphase. Single-phase motors usually possess comparatively low starting torque, while polyphase motors possess relatively high starting torque. The speed regulation in either variety of motor is good. Usually large sizes of polyphase motors only are provided with synchronous winding. Such motors keep practically perfect speed with the generators which supply them.

Synchronous motors are not ordinarily self-starting, however, and are very little used in machine shops or in connection with machine tools. They are rarely built in sizes as small as the motors we are here considering.

Alternating motors used with machine tools or in factories are generally of the induction type. The speed of induction motors may vary from nearly full synchronism with their supplying generators under no load to a slip of 5 to 7 per cent. or more on full load.

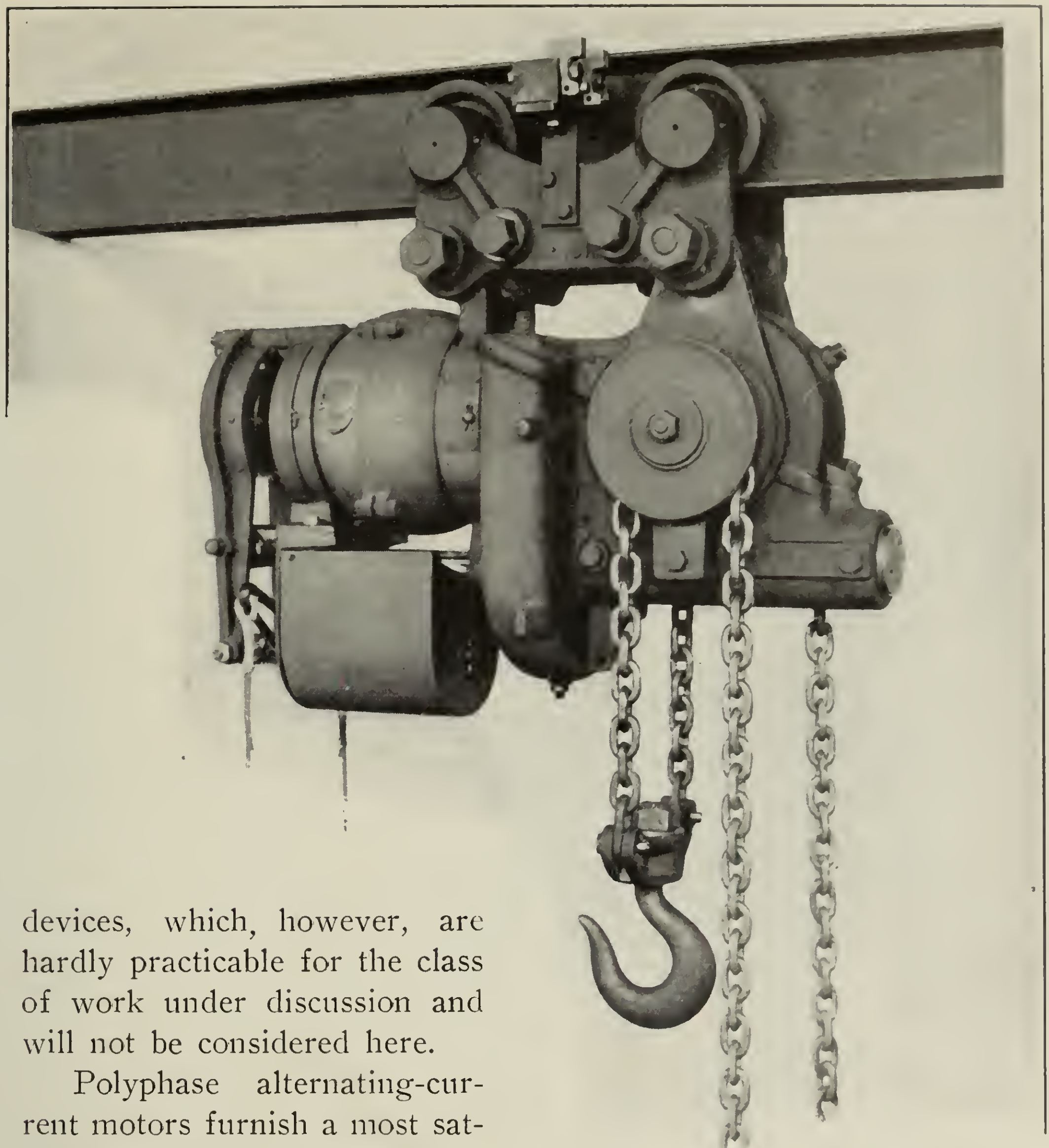
The speed of a direct-current motor may be varied within certain limits by strengthening or weakening the field without sensible loss of output. It may also be varied by supplying a greater or less volume of current to the armature.

The speed of alternating-current motors may be controlled within limits by the introduction of resistance into the armature circuits, by changes in pole grouping, or by means of special compensators or other



MOTOR-DRIVEN AIR COMPRESSOR.

Ingersoll-Sergeant Drill Co.; General Electric motor.

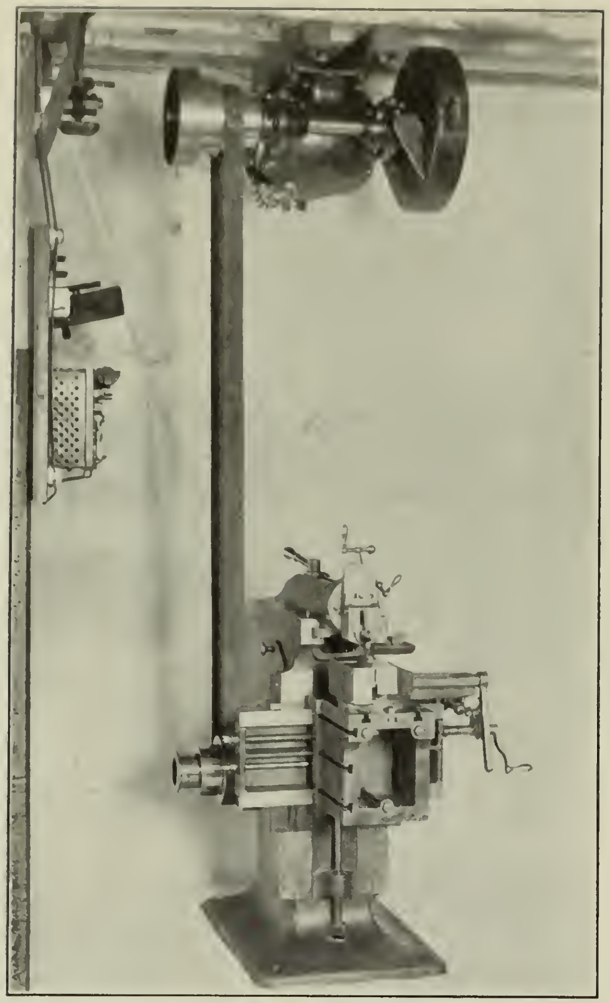


ELECTRIC-DRIVEN CHAIN HOIST, WITH PLAIN SINGLE-TRACK TROLLEY CARRIAGE.

Capacity 2,500 pounds. Sprague Electric Motor.

devices, which, however, are hardly practicable for the class of work under discussion and will not be considered here.

Polyphase alternating-current motors furnish a most satisfactory means of distributing electric power in factories and shops, where the major portion of the machines do not necessitate a wide range of speed control. They are especially valuable in an establishment where it has been decided to use a number of short distributing shafts, each shaft being driven by a single motor. In cases where the larger portion of the machinery, in any given plant, may be operated by alternating-current motors, but some variable-speed work is necessary, a motor-generator set, operated from the alternating-current mains, may be used to furnish the direct current needed for cranes and variable-speed machine tools. Direct-current motors are usually selected for equipping individual tools when wide ranges in



16-INCH GARVIN SHAPER DRIVEN BY GENERAL ELECTRIC MOTOR.

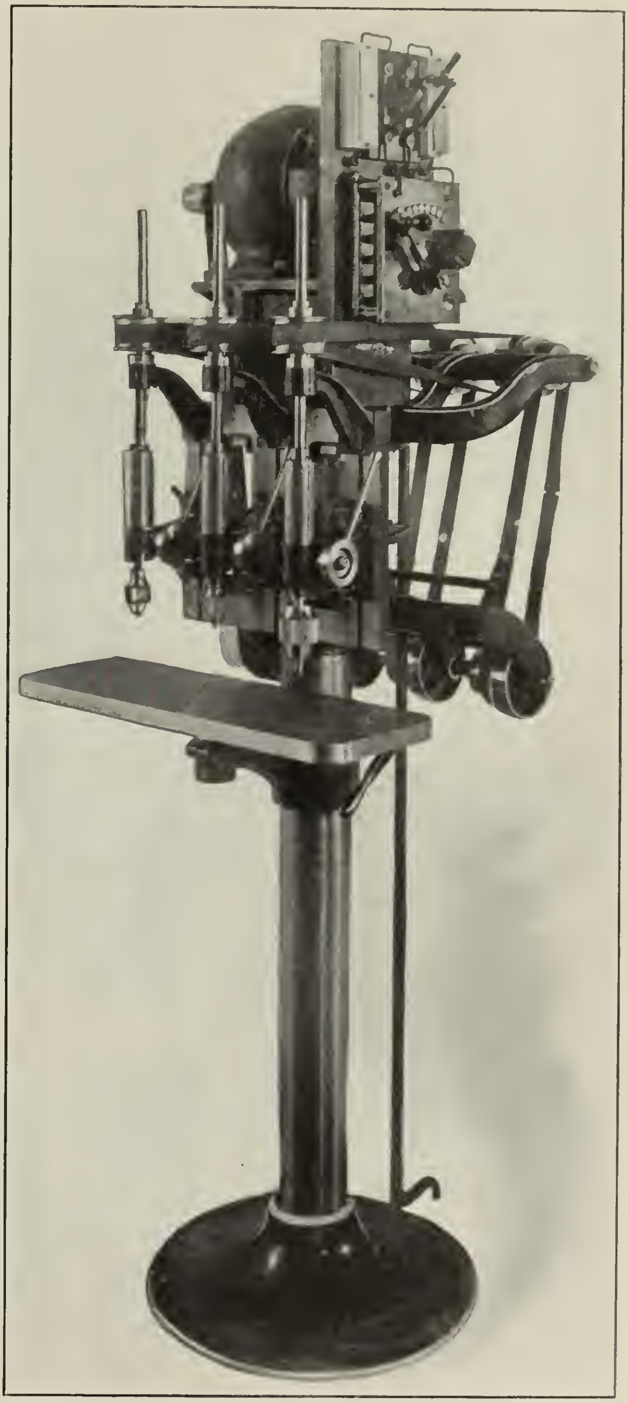
Motor is 2 horse power, 500 volt, 1,200 revolutions. Back geared at ratio of 5 to 1.

speed and close control are essential. It is not usually practicable, when using a standard direct-current motor of given normal output, to vary its speed, with a maintenance of this output, more than 5 per cent. to 10 per cent. either way by field control. With special ratings and windings the range of speed obtainable by field control may be extended within wide limits. It is practicable to decrease the speed of a direct-current motor as much as 50 per cent., or even more, with attendant loss of power, by the insertion of armature resistance. This is not an ideal method, nevertheless, when used constantly or to produce large changes.

It is impossible to produce wide ranges of speed in a motor of any normal given size and maintain constant horse-power output. To realize both conditions, the motor must be a relatively large and heavy one.

The question of electricity supply must also be borne carefully in mind when any particular problem is under consideration. It is quite possible by means of the so-called multivoltage system and the use of suitable motors in connection therewith, to extend the range of speed control between very wide limits. The use of the multivoltage system demands, however, either special and rather expensive generating plant or the use of compensators, motor generators or their equivalents. It also means a more complex system of wiring and greater expense in the installation of the same. In cases where a large establishment is to be equipped and where many variable-speed motors are required, it is always judicious to give this system full consideration; but in an ordinary factory, which is taking its power supply from a central station, or in a factory where requirements of variable speed driving are of secondary importance, this method will generally be found rather too expensive for the results obtained.

One should never lose sight of the fact, however, that where multi-voltage systems are used and a wide range of speed control thereby obtained, comparatively large, heavy, and therefore expensive, motors must be employed.

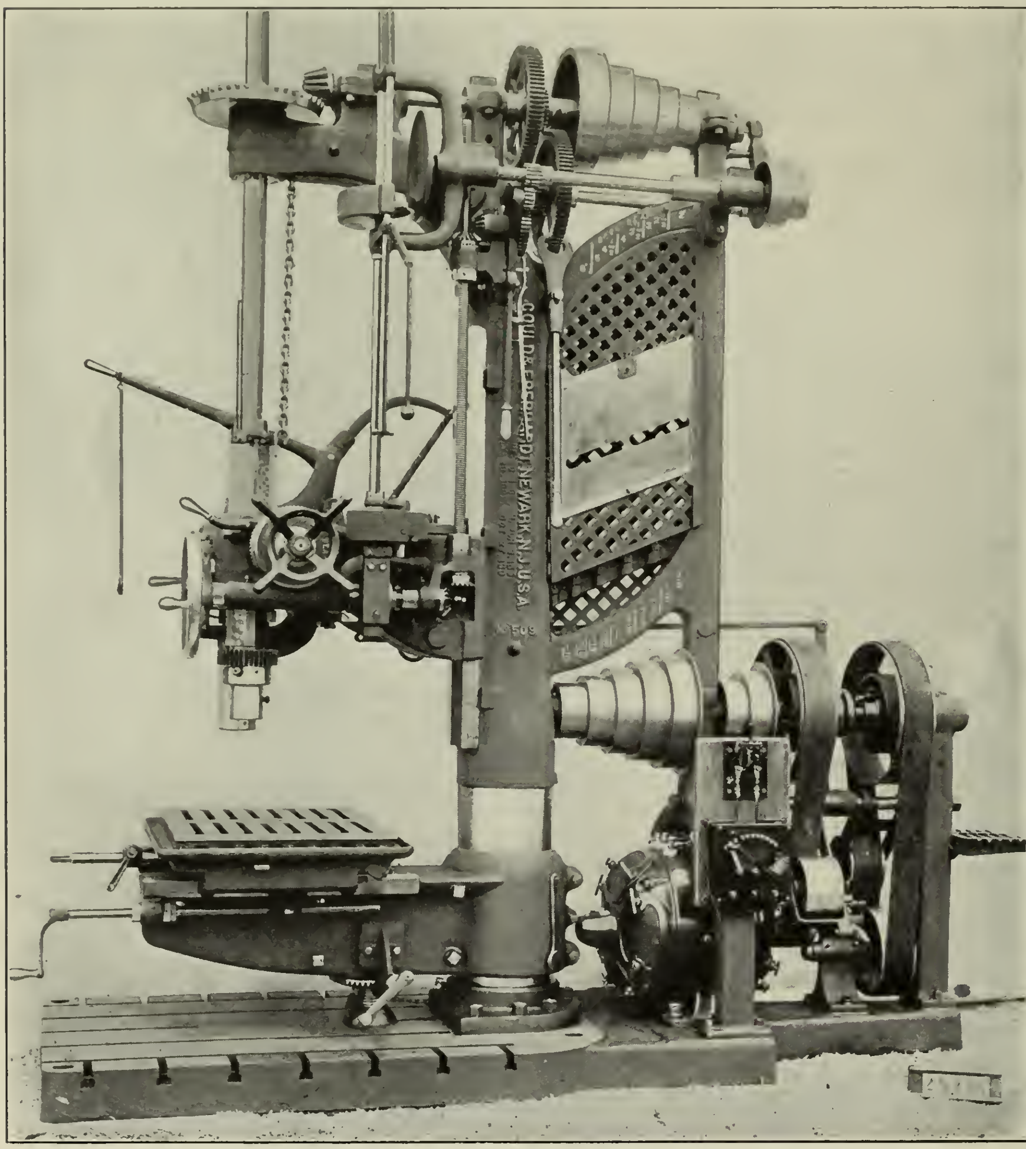


BULLOCK MOTOR DRIVING SIGOURNEY THREE-SPINDLE SENSITIVE DRILL.

In the greater number of cases which we meet, two- and three-wire systems of supply only are most conveniently available whether from central station or isolated plant. As has been pointed out above, motors may readily have a range of field control of one to two on the two-wire system, and on a three-wire system of one to four.

It is comparatively easy and inexpensive in the case of 230- or 500-volt direct-current supply to split the voltage by using a small motor generator and thus provide a third voltage midway between the others. Or, it is equally possible in the case of 115 or 230 volt supplies, by similar means, to make double voltages available. It is difficult to lay down any specific rules for the guidance of one's judgment when determining whether a shop should adopt group driving or individual tool driving. These general principles, however, have been pretty thoroughly established:—

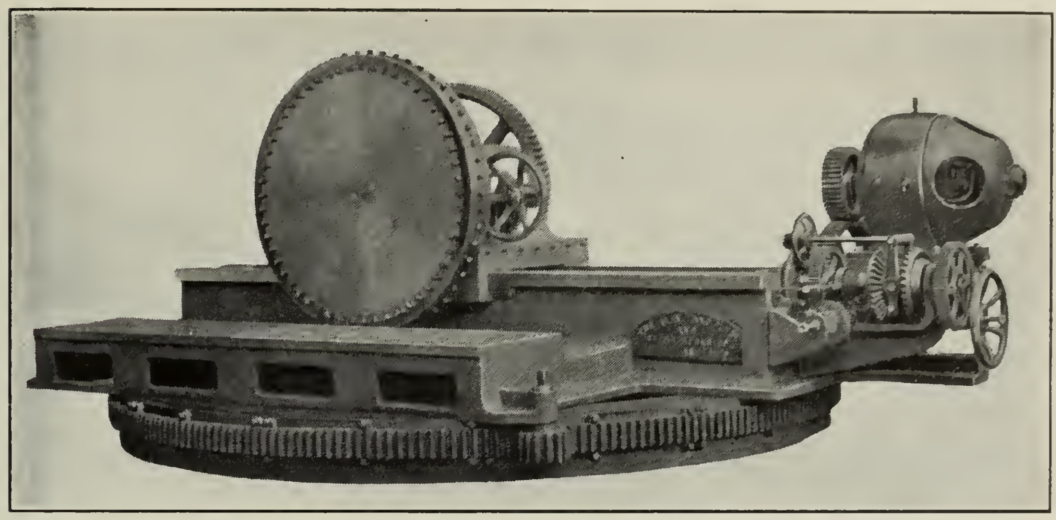
In the case of machinery running at constant speed, requiring comparatively small power for its operation, which may be compactly arranged and whose work is continuous and nearly the same day after day, it is usually best to consider first its operation in groups from short line shafts, located either above or beneath the floor and each driven by



UPRIGHT DRILL PRESS WITH DIRECT-CONNECTED ELECTRIC MOTOR.

General Electric motor, 3 horse power, 1025 revolutions, 230 volts. Drill press by Gould & Eberhardt.

a separate motor. By this method the capital account for investment in motors and accessories will be minimized, the diversity factor availed of, and power supply saved, for the economy of the drive, as a whole, will usually be higher than could be obtained by the use of individual motors. Again, maintenance and attendance are largely diminished.

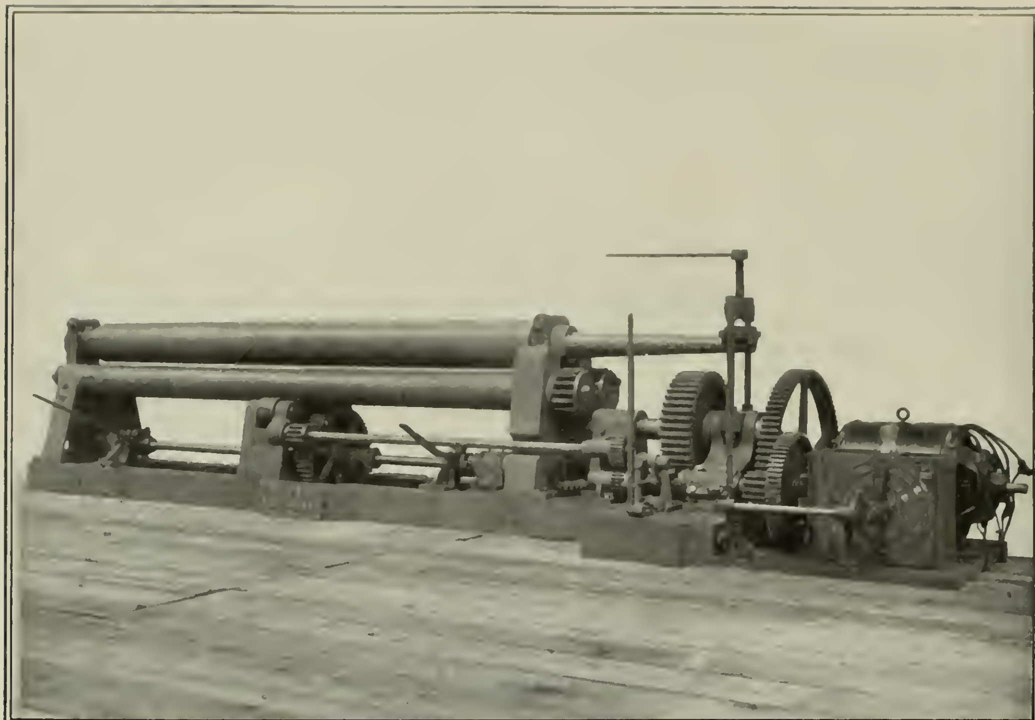


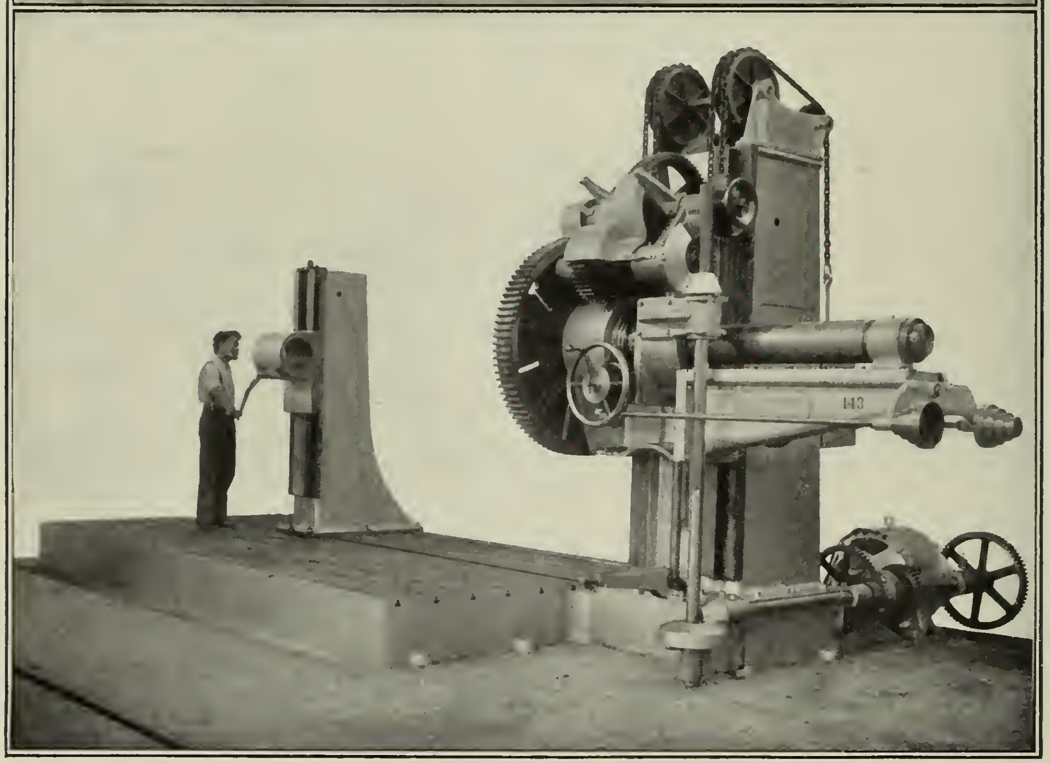
20-HORSE-POWER MOTOR GEARED TO A ROTARY PLANER.
Cleveland Punch & Shear Works Co. and Crocker-Wheeler Company.

In the case of moderately large tools requiring from one to two or more horse power for their operation, and especially in the case of tools used intermittently and subject to great fluctuations in load, or where head room for crane service, or floor space for manipulating work or the storage of stock is needed, the installation of individual motors usually seems desirable, and this is particularly true if wide variations in speed are necessary.

It is always desirable to adhere as closely as possible to the use of standard forms of motors. Such adherence on the part of a consulting engineer will tend to insure for his client motors of the highest efficiency and smallest initial cost, also better assurance of ability to obtain repair parts at short notice if they be needed at any time. In the term "standard motors," are included not only motors which are regularly listed in manufacturers' catalogues, but those semi-standard motors whose mechanical parts—frames, commutators, etc.—are standard and usual types, but whose windings may be, within limits, adapted to meet the requirements in hand.

As many machine shops have extensive wood-working departments, it may be desirable to consider briefly the equipment of wood-working tools and the power required to drive them. The quantity of



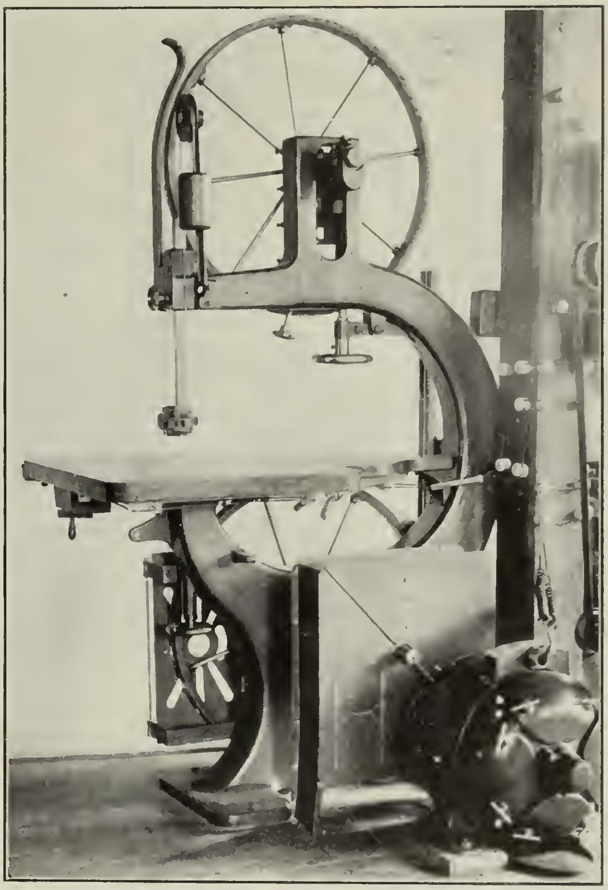


THE UPPER PICTURE SHOWS NILES PLATE-BENDING ROLLS DRIVEN BY ELECTRIC MOTOR; THE LOWER FIGURE ILLUSTRATES AN ELECTRIC DRIVEN BEAMAN & SMITH 73-INCH BORING MILL.

Electric equipment in both cases is by the Bullock Electric Manufacturing Co., Cincinnati.

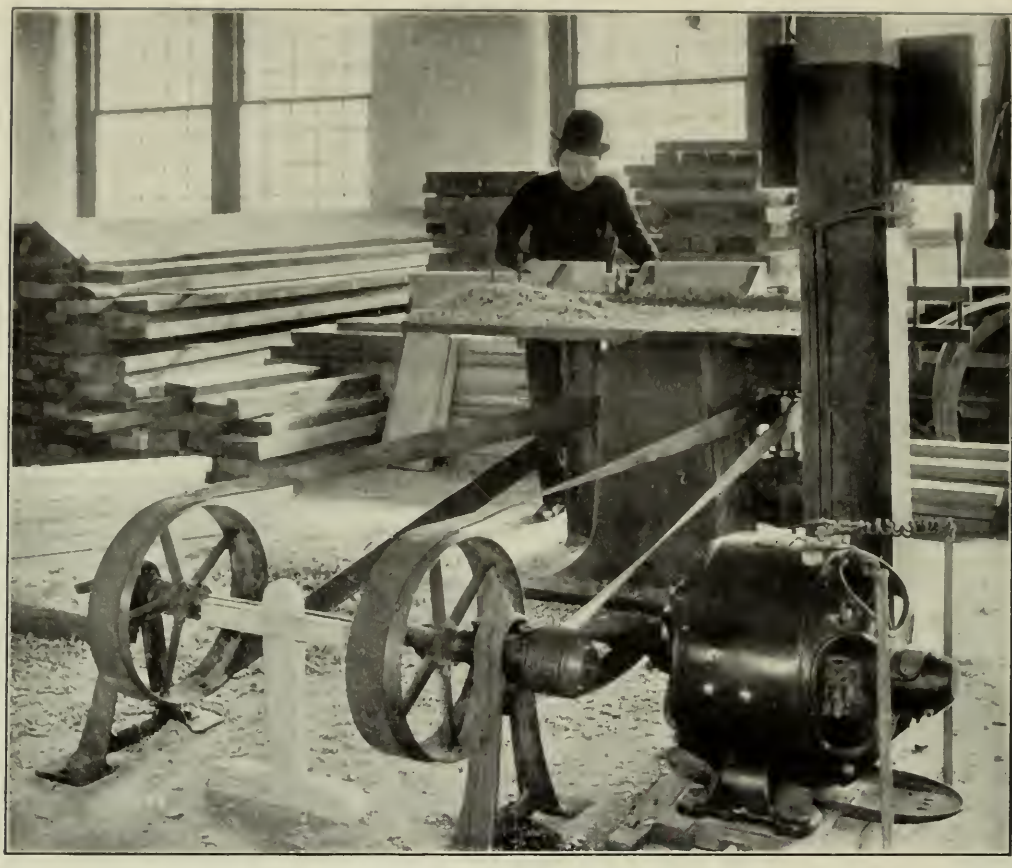
power needed to drive wood-working machinery varies greatly according to the quality and condition of the lumber used, the speed of feed, the depth of cut and, more particularly, the condition of the knives, teeth, or other cutting edges.

In this connection, it appears that one essential advantage of operating wood-working machinery by electric motors arises from the fact that a meter may be put in the supply circuit of any machine which will indicate the watts input, and a comparison of the readings thus had from time to time will show quite closely whether the machine is in good order, the feed and cut of the right amount, and the cutting edges in good condition. The importance of keeping the cutting edges of wood-working tools in good order will be apparent when it is pointed out that a given amount of work on either green or dry lumber may easily require 300 per cent. more power when the knives are dull and in poor adjustment than when they are sharp and in thoroughly good order.



BAND SAW DRIVEN BY 3-HORSE-POWER 500-VOLT GENERAL ELECTRIC MOTOR. GEAR RATIO 3 TO 1.

Electric motors are particularly applicable for the operation of wood-working tools because such tools, as a rule, require high speeds, and moderate- or high-speed motors allow the employment of the minimum quantity of belting and countershafting in their connection. Again, the power required by wood-working machines is usually much more than that needed by metal-working tools of corresponding general size, and when this large amount of power has to be transmitted through considerable belting and shafting, the losses in transmission are great in themselves. It is evident, therefore, that the expediency of equipping wood-working tools with individual motors will usually



WOOD-WORKING MACHINERY DRIVEN BY ELECTRIC MOTORS.
Shops of the Crompton & Knowles Loom Co., Phila. General Electric motors, driving by Renold's silent chain.

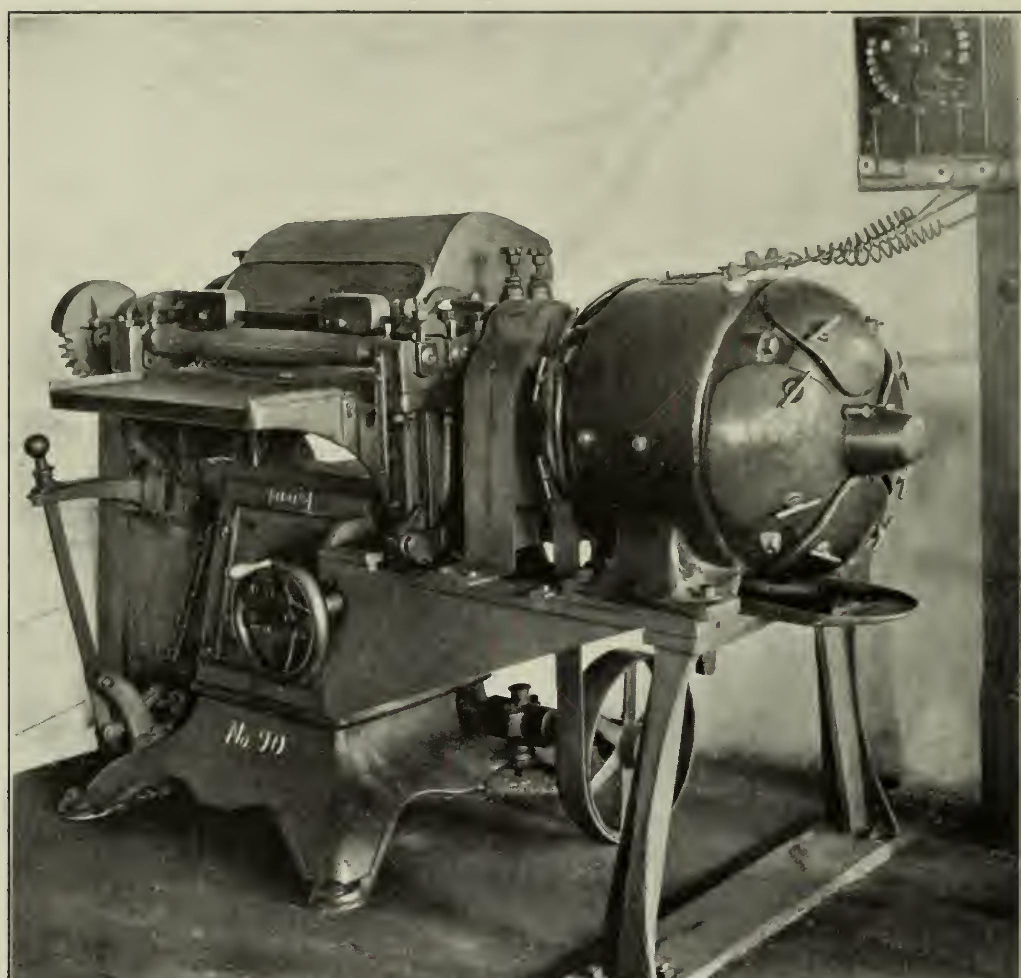
be greater than in the case of metal-working tools, for the elimination of high-speed belting and shafting will always be an important factor in economy.

Again, the material machined on wood-working tools being larger and more bulky than the work machined on ordinary metal-working tools, the matter of minimizing the floor space has to be carefully considered. If wood-working machinery be driven from shafting, its location will not be as flexible as when driven by individual motors and, consequently the amount of floor space necessary to accommodate the machines will almost invariably be more than that needed when the individual drive is used. The investment in shafting, cost of maintenance, and loss of power therein, are also important considerations.

As the use of wood-working machinery is of a rather intermittent character, motors for operating it may usually be rated on a somewhat more favorable basis than when they are used for operating metal-working machines; i. e., wood-working tools, being run at high speed, complete their cut quickly and there is a short interval before another piece of work can be fed in or made ready. Motors in wood-working shops should usually be enclosed—if not completely, then with gauze end-shield covers. It should not be forgotten, however, that such enclosure will decrease the horse-power output of the motor on continuous rating. The mere presence of wood dust in a motor is not particularly detrimental, but if it is allowed to accumulate and bake onto the windings or brush mechanism and commutator, then trouble will inevitably ensue. Motors in all situations should be kept clean, their oil cellars full, and the brushes well adjusted. This is not a hardship and requires but a few moments every few days if the person doing the work is conscientious and performs the duty properly. Dust should be blown out of motors by a bellows or compressed-air jet with sufficient frequency to prevent its caking up. If any oil is observed to have run along the shaft from the boxes onto the commutator or head winding, it should be wiped off. If the commutator should become rough, it must be smoothed with a piece of sand paper held over a block. If the brushes chip away or show signs of grittiness, they should be changed. Particular care should be observed that dust and oil be wiped away from the vicinity of all the terminal bushings and from the points where the brush-holder studs join the brush yoke. These matters

JOINTING MACHINE IN A WOOD-WORKING FACTORY, DIRECT-DRIVEN THROUGH A COUPLING BY TRIUMPH ELECTRIC COMPANY'S MOTOR.

seem trivial in themselves, but a proper attention to them means all the difference between the success and failure of a motor installation. Proprietors of shops will spend thousands of dollars to install an electrical equipment and then, through the lack of a few dollars spent to insure reasonable care of the apparatus, will incur hundreds of dollars in repair bills. This matter of inspection and care is of so much importance that I feel justified in giving it particular prominence here. Quality rather than quantity should be the governing feature in all service pertaining to the care of electric motors.



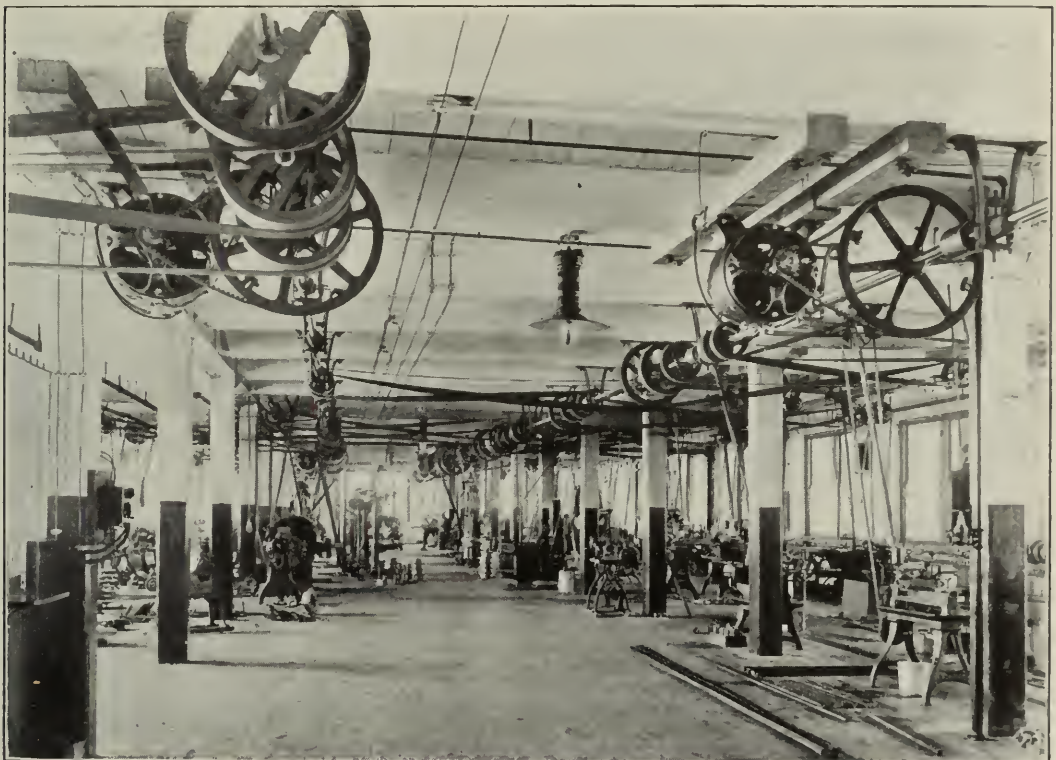
LIGHT SURFACING MACHINE, DIRECT-CONNECTED TO ELECTRIC MOTOR.

While difficult to particularize in regard to the power requirements of the various wood-working tools, the following general statements may be taken as a basis of estimate.

A direct-connected 24-inch buzz planer running at 4,000 revolutions per minute, should be fitted with a 5-horse-power motor, and this will usually carry the cut promptly and easily through any work that is apt to be put on the machine.

A 24-inch cylinder planer running at 3,725 revolutions per minute will require about 7½ horse power on dry stock and 15 horse power on unseasoned rough lumber.

Irregular double-headed moulders require from 1½ to 2½ horse power per head.



GROUPED MACHINERY IN THE SHOPS OF THE CROMPTON & KNOWLES LOOM CO., DRIVEN BY GENERAL ELECTRIC MOTORS THROUGH RENOLD'S SILENT CHAIN.

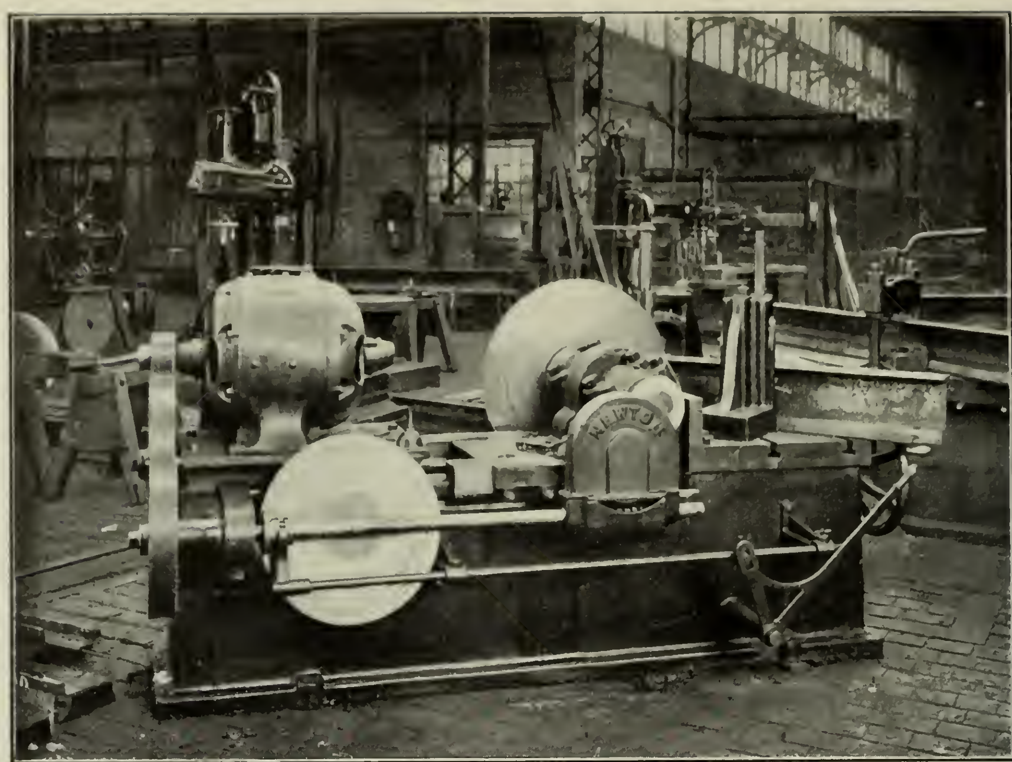
Sticking machines require rather heavy equipments. A four-sided sticking machine of average size will usually require a 10-horse-power motor.

An 8-inch circular rip saw on heavy work will require form 1½ horse power to 2 horse power. A similar amount of power will be required for a similar size cut-off saw.

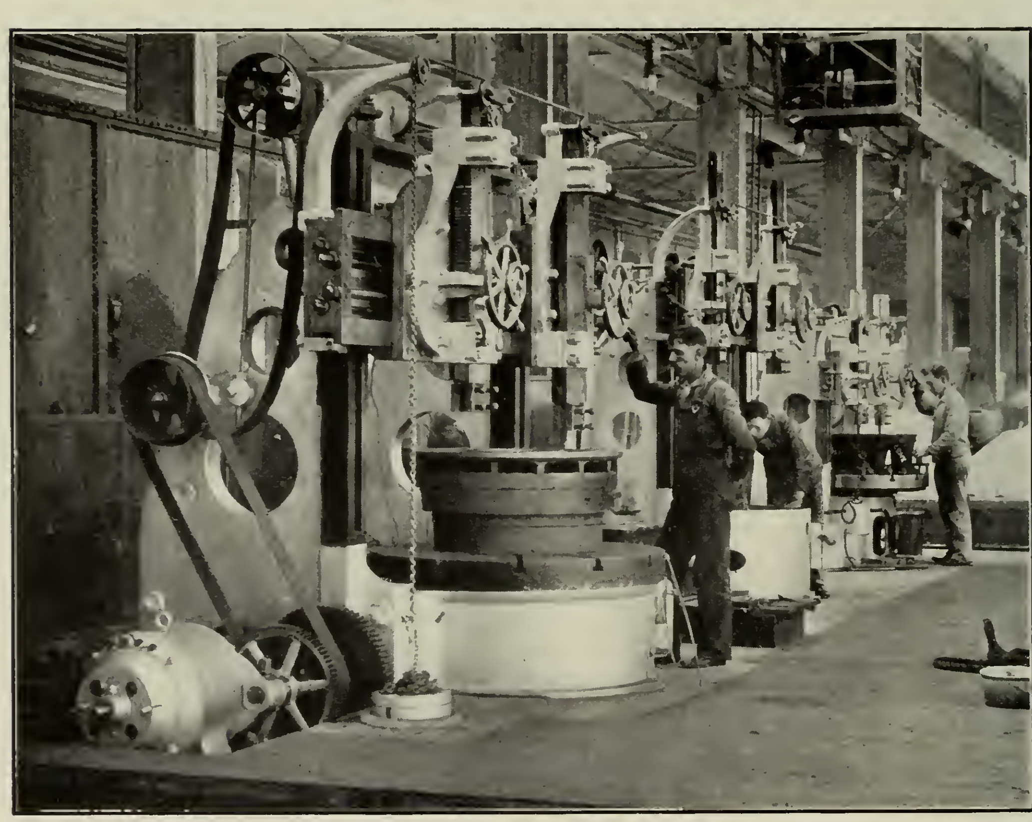
A 12-inch cut-off or rip saw will require about 3 horse power. An 18-inch cut-off or rip saw will require 5 horse power.

An ordinary band saw will require about 2½ horse power, while an ordinary jig saw will require about 1 horse power.

The above ratings assume that the tool is in good adjustment, with cutting edges in fair condition, and that the feed and cut will be as heavy as is consistent with smooth work.



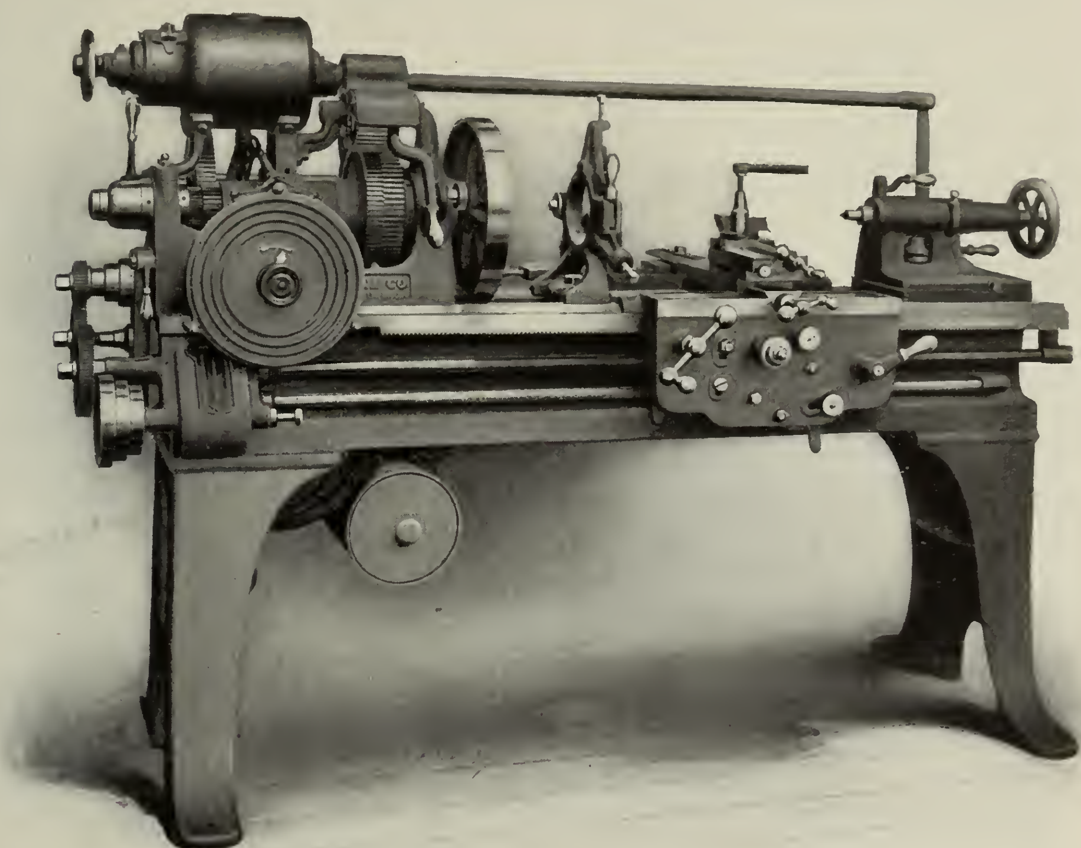
NEWTON COLD SAW DRIVEN BY GENERAL ELECTRIC MOTOR.



GROUP OF NILES BORING MILLS DRIVEN BY BULLOCK MOTORS.

The choice of motors and grouping of machinery affords a field for the exercise of unusually good judgment. As an illustration of the difference from a financial standpoint between two methods of equipping a shop, let us investigate a typical case based on and combining actual experiences.

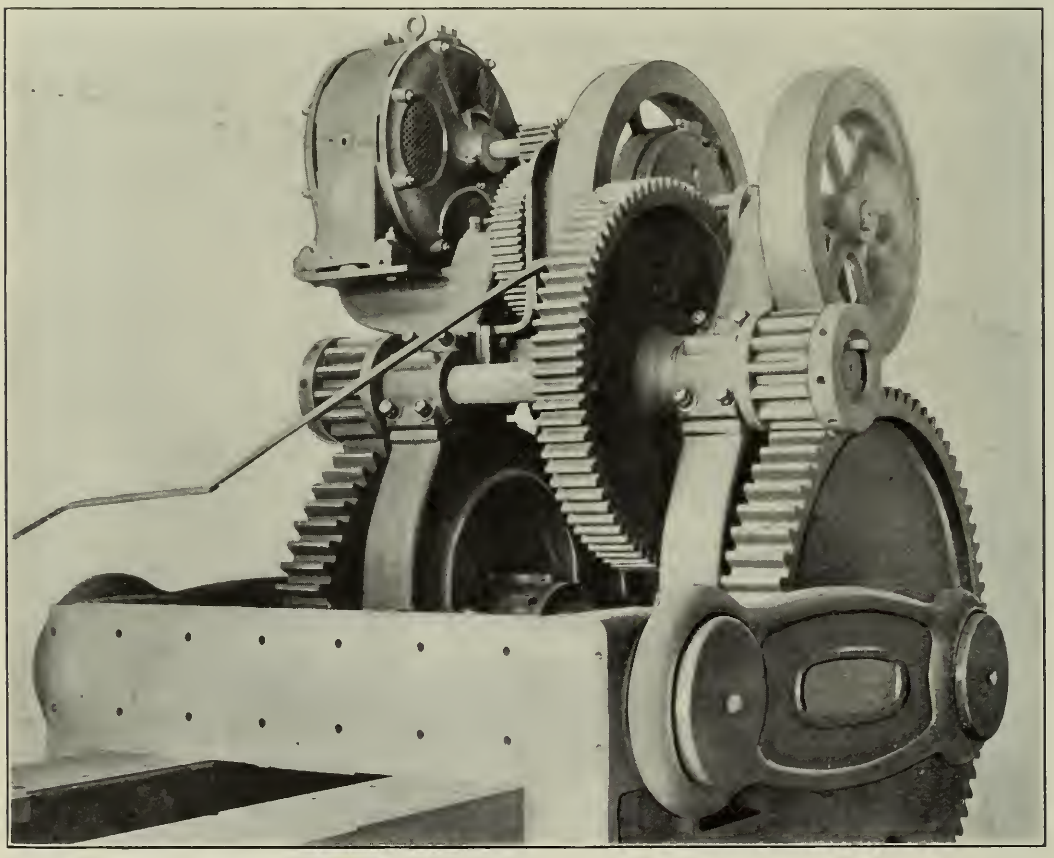
A wholesale furniture dealer, owner of a four-story storage building, uses the top floor for the manufacture of light woodwork. The building contains a freight elevator and on the top floor are installed



MOTOR DRIVEN LATHE, WITH THE ELECTRIC MOTOR MOUNTED ON THE HEADSTOCK AND GEARED TO LIVE SPINDLE. STOREY MOTOR AND ELECTRIC COMPANY.

two "Weymouth" wood-turning lathes, one buzz planer, one circular saw, and some other small special machines, the power requirements of which are so small as to be negligible. The lathes are in constant operation and the requirements of the work such that either the planer or the saw is always in operation also. The elevator is on the street front, which happens to be the darker end of the building, and the work done on the shop floor, requiring good light, necessitates the location of the machines in the opposite or rear end of the building. The elevator machinery is on the top floor and the motor near it. It is necessary to run a line shaft the full length of the building in order to supply power to the shop, and to distribute the power properly and avoid too much handling of the work, some additional light shafting is also needed.

A 15-horse-power, moderate-speed motor having been selected for power supply, it is found, after a few months' trial, that the current bills average nearly $5.00 a day; although the owner of the business is only paying 6 cents a kilowatt for current, he considers the total bill excessive. After an investigation of the conditions obtaining in his factory, certain changes are made much to his benefit. It is found that the elevator requires practically 7½ horse power to operate it, that its average use is two hours a day, and that when used it is ordinarily fully loaded. The two "Weymouth" lathes are found to require



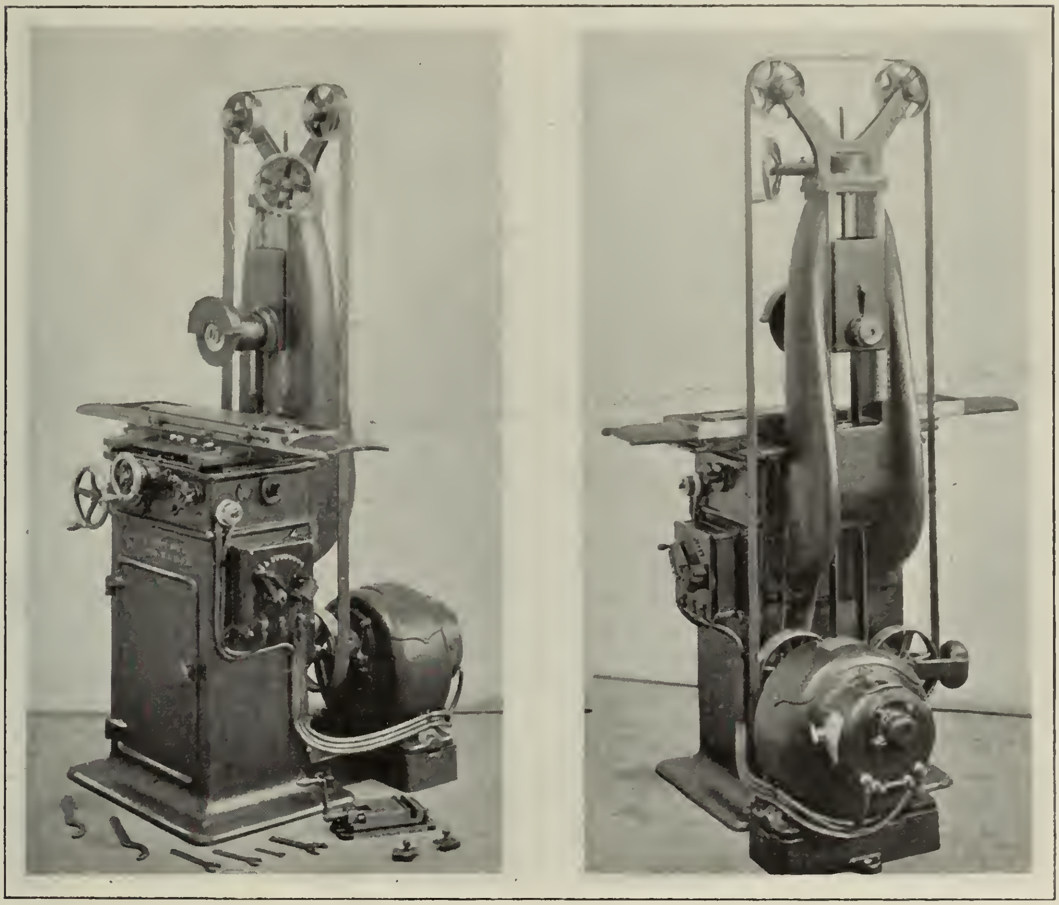
ELECTRIC DRIVEN "BULLDOZER."

Williams, White & Co., Moline Ill. Westinghouse alternating-current motor.

1 horse power each, as the work done on them is small, light, and uniform. The average requirements of both the buzz planer and circular saw are found to be 3 horse power each. The friction load on the high-speed line shaft for driving the wood-working tools, including the long and heavy belts to the elevator mechanism, is 2½ horse power,

and when everything is in operation, the 15-horse-power motor is just fairly loaded.

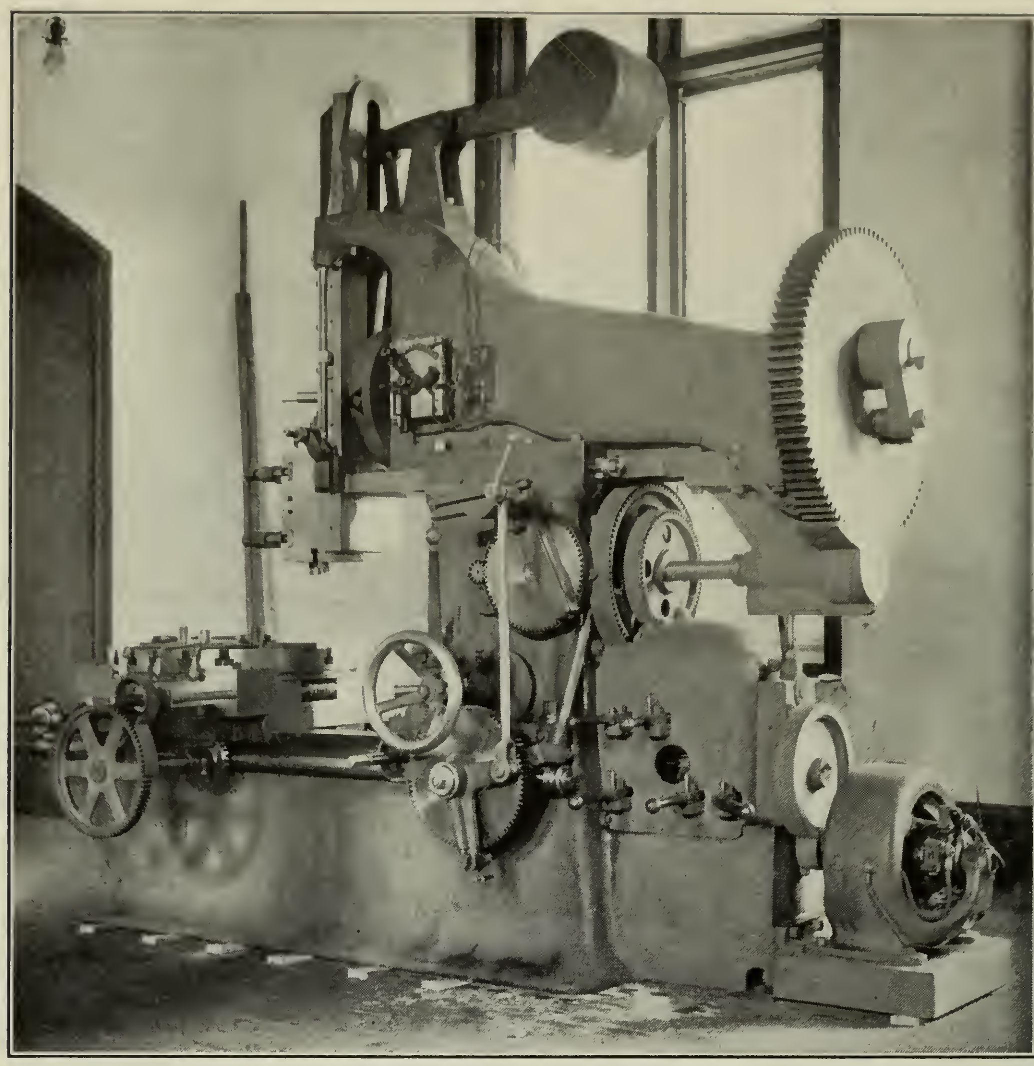
During the eight hours of the day, however, when the elevator is not at work, the motor is only about half loaded, and of the load it then carries, one-third is the friction loss before mentioned.



BROWN & SHARPE SURFACE GRINDING MACHINE DRIVEN BY 1-HORSE-POWER 230-VOLT GENERAL ELECTRIC MOTOR.

A change in motors and a re-arrangement of tools is made, the 15-horse-power motor being replaced by a 7½-horse-power slow-speed motor for driving the elevator mechanism, a 3-horse-power moderate-speed motor for driving the planer and saw, and a 2-horse-power moderate-speed motor for driving both lathes. The small special machines take the insignificant amount of power needed from the 3-horse-power motor. The long line shaft and all but two very short lengths of distributing shafting are cut out, as the 7½-horse-power motor is set close to the elevator mechanism.

The result of this change will give an average saving of $1.34 per day, or $415.40 a year of 310 working days. The 15-horse-power motor running under full load with an efficiency of 88.2 per cent. two



ELECTRIC MOTOR DRIVING A 12-INCH SLOTTER, UNITED STATES MINT.
T. C. Dill Machine Company and Crocker-Wheeler Company. The motor is 3-horse-power. Different speeds secured by gear changes.

hours per day would entail a charge of $1.52; during the remaining eight hours when it ran on half load at 81 per cent. efficiency, it would use $3.32 worth of current—a total of $4.84 per day. By making the suggested change, the 7½-horse-power slow-speed motor would work two hours a day at full load with an efficiency of 86.5 per cent., and the current charge would be 78 cents; the 2-horse-power motor would run ten hours a day and at full load with an efficiency of 81.9 per cent., and the current charge would be $1.09 per day. The 3-horse-power moderate-speed motor would operate 10 hours a day at full efficiency, 82.2 per cent., with a current charge of $1.63—making a total for the three motors of $3.50 per day.

The saving, therefore, resulting from the change in equipment, would be $1.34 per day or $415.40 per year.

Suppose the 15-horse-power motor originally cost $295. The motors purchased in its place would have cost about $425, or $130 more than the single machine. It will be observed that the saving in current would nearly pay for the three new motors in the first year; if the difference in prices between the 15-horse-power motor and the three smaller motors—i. e., $130—had been paid originally, the owner would have enjoyed a net gain of $285.40 at the end of the first year, or the interest on an investment of $5,700 at 5 per cent. The re-arrangement would not only result in financial saving but do away with the maintenance and inspection of the shafting and thereby reduce the danger from fires due to overheated boxes, and the wear and tear of long belts.

As long as the 15-horse-power motor was in operation, the owner would not only be paying for all current really needed, but losing an additional sum of money which, if capitalized, would be equivalent to an investment of $8,300 for his motor, a sum which, if to be spent at once, he would not have thought of paying.

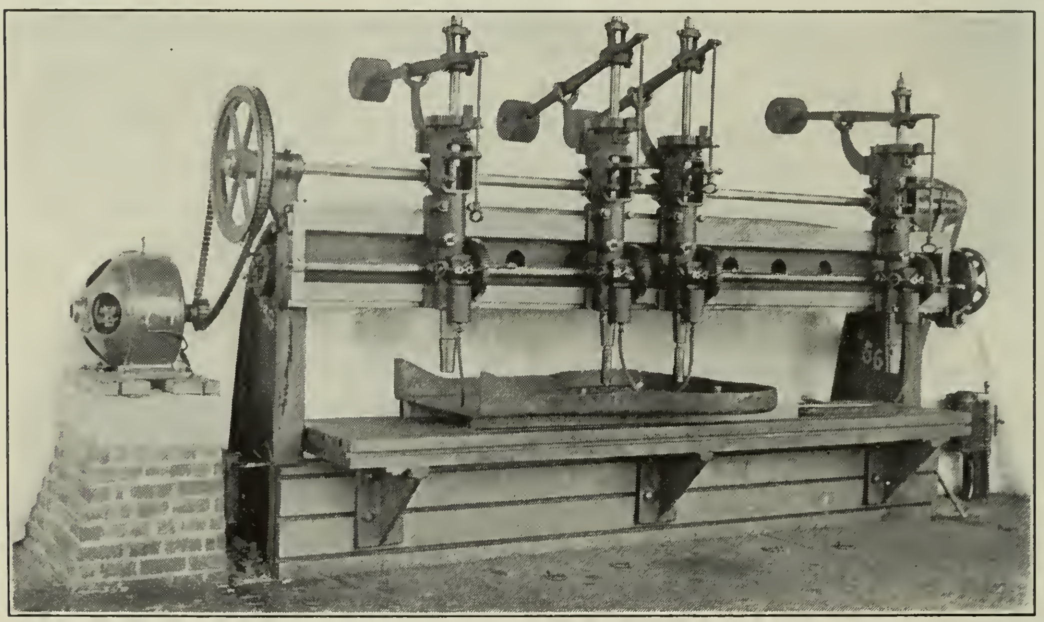
The saving of $415 a year would not only nearly purchase a complete new equipment of motors every year if needed, but as the average life of a motor, conservatively estimated, is at least ten years and repairs may be figured at 5 per cent., at the end of ten years all the motors could have been replaced and a cash balance of some $5,000 realized, if the savings had been banked from time to time, at 4 per cent.

Motors on individual tools should be mounted over the center of gravity and as near the base of the tools which they serve as possible. They should also be fully protected from chips, oil, and the possibility of mechanical injury. Simplicity of connecting drives should always be aimed at. Brass-shrouded rawhide pinions, working in steel gears, are usually satisfactory. The use of the Renold "silent chain" also affords a very satisfactory method of transmitting power from the motor to the moving parts of machines.

The application of motors to machine tools having a reciprocating motion, such as planers, shapers, and slotters presents some difficulties of special importance. Instantaneous and frequent reversal of a motor should be avoided, as much as possible, on general principles. A suitable gear train may usually be availed of to give reverse motion, the forward or return stroke of the tool being governed by electric clutches or other suitable devices. When a motor is to be subjected to violent and sudden changes in load, a flywheel on the armature shaft will often be of great advantage in preventing shock to the armature and thus minimizing sparking and cutting at the commutator.

MOTOR APPLICATION TO PUNCH AND STRAIGHTENING PRESS.
Hilles & Jones Company tool, Crocker-Wheeler 15-horse-power motor.

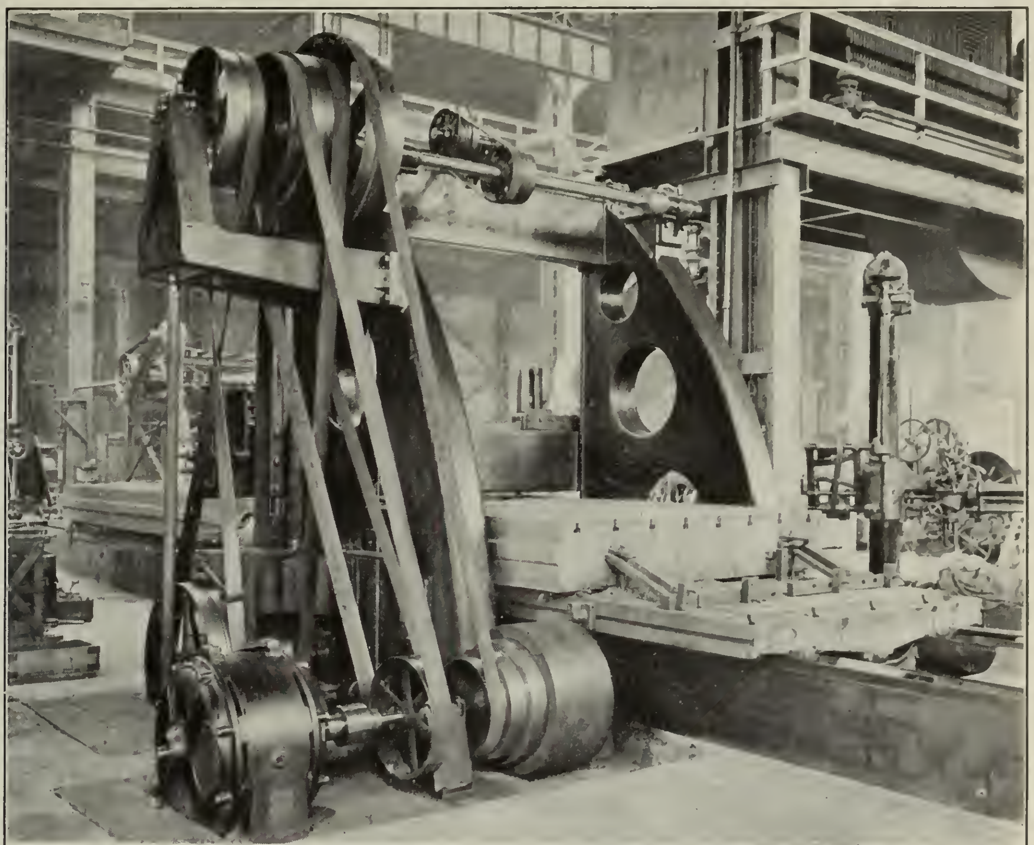
It is desirable to insulate the motor from the frame of the tool when this can conveniently be done. The insulation should be of most excellent quality, however, proof against water and oil, and of such character as to keep its shape and rigidity under all conditions. Great care should also be taken to protect the motor terminals and the wiring system from possible contact with the workmen operating the tool. The various tubular conduits made by the Sprague Electric Co. of New York seem especially well fitted for enclosing the wiring on machines. An effort should be made to locate all controllers and



ELECTRIC DRIVEN MULTIPLE-SPINDLE DRILL, L. S. & M. S. RAILWAY SHOPS, COLLINWOOD, OHIO.
Niles tool and Crocker-Wheeler 7½-horse-power motor.

switches so that they will be very accessible and convenient to the workmen. They should also be enclosed or semi-enclosed in such manner that all metallic portions carrying current are fully protected.

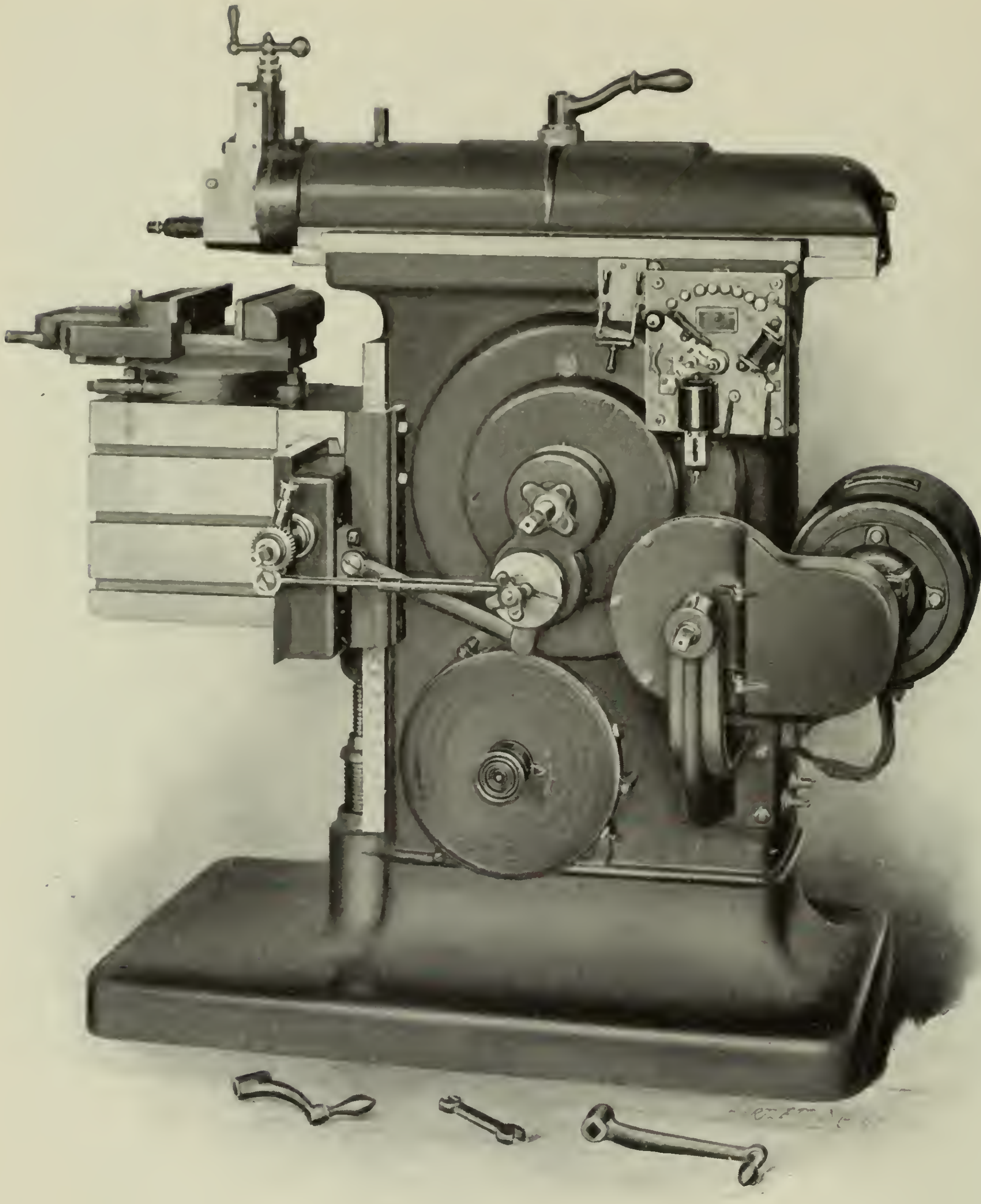
In laying out a line of new machine tools, it is a comparatively easy matter for the designer to make all necessary arrangements for attaching the motor which he proposes to use. Planing bosses, pads, or brackets may readily be incorporated into the design of the machine.



HEAVY PLANER OPERATED BY ELECTRIC MOTOR. WORKS OF NEW YORK SHIPBUILDING CO., CAMDEN, N. J.

30-horse-power Westinghouse alternating-current motor. Planer by Betts Machine Co., of Wilmington, Delaware.

As there are, however, a great many thoroughly good and satisfactory tools in use, which the owners would not care to cast aside for modern self-contained motor-driven tools, it is often necessary to provide motor supports on machines already in use. Skeleton brackets and other structures made from "channel," "T" and "I" beams may often be advantageously employed. In a number of cases low sub-bases have been made, on which the tool and its motor were both assembled, and the drive effected either by belt, chain or gears. In such cases the complete motor-driven tool may often be transported from place to place by an overhead crane and landed wherever it can most advan-



STOCKBRIDGE SHAPER DRIVEN BY ELECTRIC MOTOR.
Storey Motor and Electric Co.

tageously be used, current being brought to it by means of a cable connection from a wall outlet.

When supporting brackets and pads have to be secured to the frames of tools already in use, a very satisfactory method of fastening them without the necessity of planing or dressing the surfaces to be joined is to drill and tap the machine frame for such pads or brackets as are needed and then fasten them approximately in place with cap screws. When they have afterward been lined up by means of small wedges, the joint may be dammed with putty or clay and hot type metal poured in the opening to make a seat. After the type metal has cooled and the cap bolts are tightened up, it will be found that a very substantial and satisfactory support for the motor has been obtained.

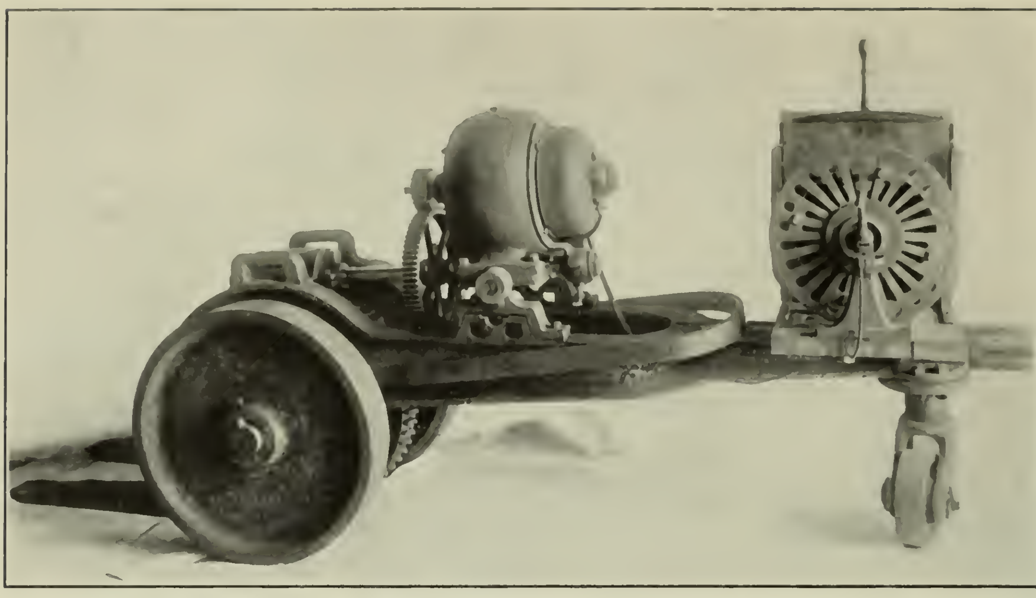
When motors are mounted on machine tools and transmit their power by short belts, provision should always be made—unless an automatic belt tightener is used—to rock the base, on which the motor rests, by a compound lever or screw in such manner that the tension may be quickly thrown off the belt if necessary.

When short line shafts are used to distribute power, it seems desirable to adopt some one of the anti-friction hanger boxes. There are two or three varieties of interchangeable boxes now on the market which may be used for decreasing friction in shafting hangers with excellent results. It should always be remembered that it costs a great deal of money to keep pulleys, shafting and belting in motion, especially if the overhead works are heavy and considerable power is being transmitted. In a recent case, for instance, it was found that the cost of operating one line shaft in a small shop was about $1.46 per day, or $452.00 per year. The use of an approved variety of non-friction boxes would have undoubtedly reduced this loss very materially.

Even in an engine-driven shop there are often isolated machines which are used intermittently that might be operated to better advantage and at less expense by motors taking their current supply from a central station even, than by belt and shaft transmission, such transmission often requiring an expenditure in belting and shafting, and operation and maintenance of the same, that would more than compensate for the cost of a motor and its installation.

When the product of a shop consists of articles so heavy that crane service is needed for practically all of the machines, it is rarely possible to use group driving, and in such a case the gains, arising from the possibility of universal crane service, will often more than compensate for the extra cost of equipping a large tool with its own motor, and it may also be pointed out that in such shops the power requirements of the tools usually demand a moderately large motor, with variable speed control, in any event.

While it is desirable to keep efficiency of operation and saving of power always in mind, the real and final object to be sought is maximum production with a given investment in machinery and buildings. Hence, as the cost of power alone is always relatively small, one would



NORTHERN ENCLOSED 3-HORSE-POWER MOTOR DRIVING A FOUNDRY TRUCK.

The arms at the left are inserted under the pots of melted metal and raised by an eccentric so the truck wheels take the weight. Motor operates through gears (as shown) to move the truck at the will of the operator. The controller handle is seen over the swivelled wheel at the right. The reel carries the wire conducting power to the truck.

be perfectly justified in using a rather inefficient motor or drive, in an exceptional case where it fully met some special requirement and enabled production to be largely increased.

In general the savings to be derived from the use of the electric drive will not be so apparent in the saving of power measured in or expressed by its direct money value simply as in the utilization of wasted power to productive purposes. From 2 per cent. to 5 per cent. of the cost of the product made in a large average shop may be in power. A saving of 10 per cent. in this item alone is comparatively trivial when compared with the gains to be derived from a 10 per cent. increased production due to the utilization of power formerly wasted.

The demand for motors and motor-driven machines is increasing at a marvellous rate, and every reputable manufacturer of such products is operating his works at the fullest capacity. Distribution of power by electricity holds first place, and progressive manufacturers throughout the world are now fully committed to its use. The preliminary and missionary work has practically all been done, and builders have only to produce and offer sturdy and efficient motors and motor-driven tools of suitable design to reap the rich harvest which is just now ripening into full maturity.

PURCHASE BY THE ORGANIZED FACTORY.

By Horace L. Arnold.

The article below is the converse and supplement of the cost-keeping series which have attracted so much attention in these pages in the past. They dealt with the systematic knowledge of the output of the shop. This treats of the systematic knowledge and control of the material coming into the shop.—The Editors.

PURCHASE by the unorganized factory, owned and managed by a single individual, is a simple matter. The manager probably has his regular source of supply, and perhaps has a standing order there, and so merely files the invoice when it comes in, or if he is very old-fashioned, has his book keeper copy it at length in his invoice book. The factory foreman or superintendent or the teamster may report receipt of material, and the manager may himself inspect it into the factory. The book keeper may have an account with invoices payable, or may not, and the check to satisfy the invoice may, and probably will, reach the vendor at the expected date. The material itemized on the invoice may go to the factory stores, and be entered in the stores-room ledger, which is pretty certain to be a book, (and also pretty certain to be a source of private doubt on the part of the stores keeper), or it may go directly "onto the job," without any receipt whatever from the factory to the counting room.

Quite likely the order is in excess of the expected demand—"Better have enough, so as not to have to order twice"—and it is not impossible that in spite of the excess received, there may be a shortage in the factory before the job is ready for shipment. Such things have been known, even in very well managed shops, and form a part of the daily trials and vexations in many shops which, after all, pay their way and make good work. When the shortage is discovered, at the last minute, perhaps, there is a sixes and sevens discussion. If the teamster inspected the stock into the factory he vouches the correctness of his report, which is generally reliable in proportion to his illiteracy, the man who cannot make a written record commonly having a tenacious memory of the few facts he impresses on the comparatively blank pages of his mentality. If the owner or superintendent inspected the material into the factory, then all certain trace of it is hopelessly lost. The owner is not sure, the shop head is not sure, and all the workmen in the place have had access to the material in dispute for days or weeks or maybe months. If the material went into the stores room and was recorded on the stores ledger, and was formally requisitioned out by the "department of production," then the case is more narrowly defined in form, but not in fact. The owner does not question the honesty of the stores keeper, because he knows him well, but the stores keeper cannot show the material, the factory foreman is sure he requestioned into the factory only what was required, the boss of the assemblers knows he never had any "over" parts, and after much turmoil of a wholly unprofitable nature, all hands conclude the only thing to do is to order more material, and have it in the factory as soon as possible.

The sequel to this comedy or tragedy of the missing purchase may be a resolve on the part of the owner to "fix things" so that no such muddle will ever occur again, and if he knows how some other factories make purchases and receive and store and disburse material, and keep track of that material in its journey through the factory departments right up to the shipping room and bill clerk and transportation receipt, this perturbed owner may really make an attempt to know what he buys and pays for, and where it goes to.

Stores may be missed in any factory, or bank either, for that matter, or from any express company's iron box on a fast train, or from the strong room of a swift steamer, or the privacy of the dwelling, or from the final crypt itself, where the weary are at rest; but in the organized factory two things are certainly present in case of materials received by the factory. First, some one makes a sure record of the receipt of materials, to satisfy either all or part of the invoice as received, and the stores keeper holds somebody's receipt for all of his disbursements, unless the stores room has been looted.

The modern factory organizer reverses the proverbial injunction first to catch your hare, and provides a place to keep the hare safe and in good condition before it reaches the factory. The stores room is the factory name for this place or apartment where purchases are received and stored, and the stores room may be any structure whatever, or no structure—simply a yard, unroofed—and is often a shed, and often a wire-netting-enclosed division of the main factory floor. The stores room is usually operated with locked doors, which might possibly be clock-actuated. It may have stores receptacles of any sort, and stores records kept in books or on cards.

The factory organizer is not always strictly orthodox in his personal views of the world to come, but so far as this world is concerned

DATE		MATERIAL	QUOTED BY	PRICE	TERMS	REMARKS
Nov	6/02	Steam, gas, water pipe	Allen & Reed	$\frac{1}{8}$ to $\frac{1}{4}$ 60%	usual	Job. Prov.
"	"	"	"	$\frac{3}{4}$ to $4\frac{1}{2}$ $67\frac{1}{2}$	"	"
"	"	"	"	$4\frac{1}{2}$ to 12 65	"	"
			PATENTED MAY 25. '97			LIBRARY BUREAU, A462

FORM I. PURCHASE AGENT'S QUOTATION CARD.

5 by 3 inches, ruled in red, blue, and black. Filled by agent from correspondence or other information, and filed alphabetically by stores-room designations. Each card refers to a single article. Old cards are destroyed as they are replaced by newer ones. Filed in cabinet on purchase-agent's desk.

he invariably turns to Scripture for his guiding text, and declares with inexorable pessimism that no one man can safely be relied upon to give an infallibly correct narration of occurences, and that "in the mouth of two or three witnesses shall every word be confirmed." So the organizer places two men in the stores room, the receiving clerk and the stores keeper and disburser, and provides a card stores ledger, and is then ready to buy stores, as he has a place to put them in and men to receive and hold them.

Purchase Quotations:—Before the factory can make a purchase it must know who can sell the required material. The old-fashioned office buyer kept his book of tenders. The new factory purchase office keeps a card file of quotations, in a cabinet, usually in easy reach of the left hand of the purchase agent. A well devised quotation-card form, partly filled, full size, is here given as used by the Cottrell purchase agent.

The purchase agent must have a place where he can write, and he can use several other aids in his work, but he need not occupy much room. Having provided what is necessary, the factory organizer is ready to install his purchase agent, whom he selects with care to secure intelligence and avoid delays. He does not expect him to avoid errors, but he so plans and arranges his purchasing forms and procedures that all mistakes should be discovered before the error can leave the hands of the man who makes it.

Who May Request a Purchase:—Obviously any head of a department, or any leading workman, for that matter, may be the first one to know that the factory is in need, and so may be the proper person to ask the stores keeper if he has the requirement on hand. Suppose that he has not; then the stores begin the process of replenishment by sending Form 2, blue, filled by the stores keeper, to the "Department of Plant." The head of this department of plant, or general factory superintendent, then approves and vitalizes Form 2 by filling the "Ordered From" space and standing order number, and then, after

<table>
<tr><td>Purchase Order</td><td colspan="2">Department</td><td>Date
190</td></tr>
<tr><td>Quantity</td><td colspan="3">Description</td></tr>
<tr><td colspan="4">Order From</td></tr>
<tr><td>Purpose</td><td>S. O. No.</td><td colspan="2">Wanted by what date</td></tr>
<tr><td colspan="2">Required by</td><td colspan="2">Approved</td></tr>
<tr><td colspan="4">C. B. COTTRELL & SONS Co. REQUISITION FOR PURCHASES</td></tr>
</table>

FORM 2. DEPARTMENTAL PURCHASE REQUISITION.

5¾ by 3¾ inches. Ruled in black on pale blue paper.

singing his name in the "Approved" space, places it in the "out" basket on top of his desk, whence a constantly itinerant messenger soon conveys it to the purchase agent.

It will be observed that the purchase authorization must come from the head of department of plant, who is the supreme factory ruler. Others may inform the autocrat of the needs of his domain, but he alone can fill them. The volition and discretion of the purchase agent extend only to an examination of sales agent's samples, and a recommendation of them if satisfactory to him. If satisfactory also to the department of plant, then the quotation goes on the proper card,

PURCHASE ORDER No.______________
PRICE CORRECT______________
EXTENSION CORRECT______________
QUANTITY CORRECT______________
VOUCHER NUMBER______________

FORM 3. RUBBER STAMP IMPRESSION. Full size. Printed in red on the face of every invoice received by purchase agent, who fills first three spaces. The last two are filled by head of department of plant.

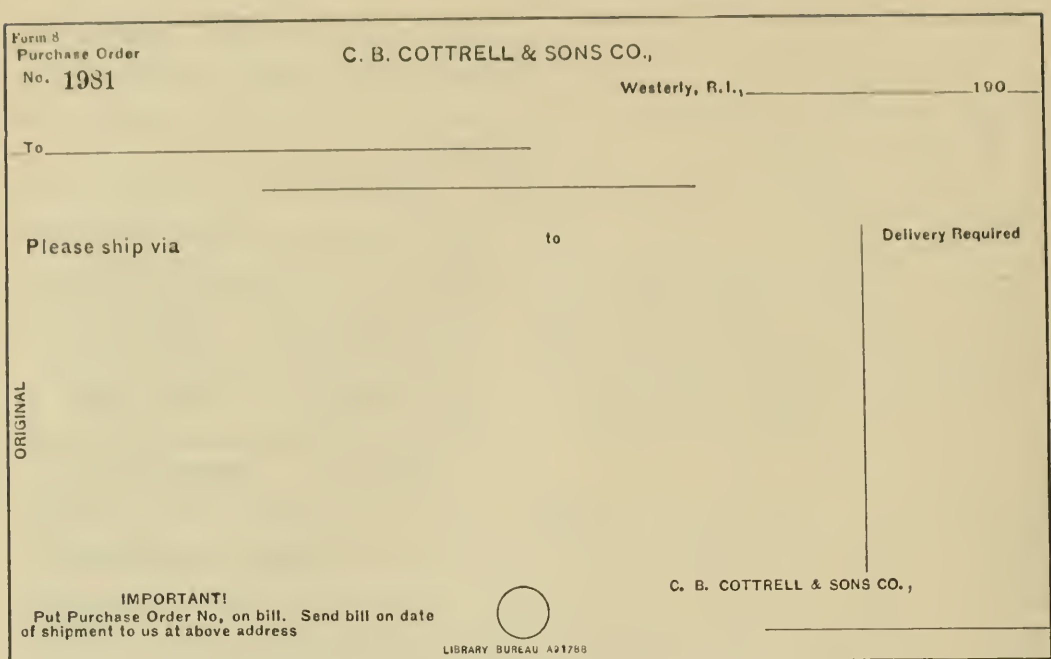
and the purchase agent can select his vendor, unless he is directed where to place the order.

Making the Order:—So far, only one written specification of the proposed purchase has been made by filling Form 2. This must not leave the factory because it tells what is wanted, what the wanted thing is wanted for, who wants it, and because it records the approval of the department of plant, and so authorizes the purchase agent to order the material sent to the factory. Hence there must be one more paper written, and this paper must perform many functions. First it must order the vendor to make the shipment of his wares to the factory. This will bring the material to, say, the factory door; then the department of plant, or factory superintendent, must be informed of this arrival, correct weight and condition certified. The store's receiving clerk will fill some kind of a form blank to say that he has received certain articles in good condition. The purchase agent must also be notified of the arrival of the order at the factory. To save clerical labor, and to keep the total number of form blanks as low as possible, the order to the vendor is made on a blank form so devised that this letter, which is to be sent away from the factory by mail, may be filled in carbon-copy duplicate and triplicate, all certainly alike. Obviously these three documents, the original and the two carbon copies, should bear the same number. Obviously, also, there should be some distinguishing difference between the three documents, which are identical in wording.

To meet all these requirements, Forms 4, 4 A, and 4 B, which see, are provided, and when the purchase agent receives an order on Form 2, he has only to turn it over to his typewriter, who proceeds to take a white Form 4, and yellow Form 4 A, and a blue Form 4 B, all identical in size and printing, and write the three at once in original, carbon duplicate, and carbon triplicate, and then returns Forms 2, 4, 4 A and 4 B to the purchase agent, who compares 4 with 2, and

__________ to S. O. No.__________
__________ to S. O. No.__________
__________ to S. O. No.__________

FORM 3 A. RUBBER STAMP IMPRESSION. Printed in red by purchase agent on the face of every order received. Standing-order spaces are filled by him from his yellow Form 4 A.



Form 8
Purchase Order
No. 1981

C. B. COTTRELL & SONS CO.,

Westerly, R.I., ______________ 190__

To ______________________________

Please ship via ______ to ______

Delivery Required

ORIGINAL

IMPORTANT!
Put Purchase Order No, on bill. Send bill on date of shipment to us at above address

C. B. COTTRELL & SONS CO.,

LIBRARY BUREAU A21788

FORM 4. PURCHASE ORDER. FORMS 4 A AND 4 B ARE SIMILAR, EXCEPT IN COLOR.

7¾ by 4¾ inches, thin white paper. Form 4 A is yellow, and bears the word "Duplicate" in place of "Original," at the left. 4 B is blue, and is marked "Triplicate." All are filled by purchase agent simultaneously, by carbon copy. Form 4 (white) is sent to mailing clerk, and forwarded by him to the seller supplying the goods ordered. The purchase agent retains the yellow duplicate for record; the receiving clerk gets the blue triplicate to verify the goods received.

if correct, signs 4, 4 A and 4 B, and then sends white Form 4 to the mailing clerk, blue Form 4 B to the receiving clerk in the stores room, and files the yellow Form 4 A in a temporary "waiting tray."

Form 2, having served the several purposes of notifying the department of plant of factory need, and conveying the department of plant's order to fill that need to the purchase agent, and having dictated the letter to the source of supply which is typewritten on Form 4, has now performed all of its regular functions, and is sent by the purchase agent to the department of plant and filed in the card cabinet drawer marked "unfilled orders," there to remain as an available witness to all the procedures preliminary to the mailing of the purchase order. At this period the purchase agent has a yellow copy of the order in his "waiting" tray, and the receiving clerk has his blue triplicate in a "waiting" file in the stores room, and knows that he may expect the ordered material at about a certain future date.

It will be observed that Form 4 has printed in its lower left corner, "Important! Put purchase order No. on bill. Send bill on date of shipment to us at above address."

The vendor is bound by commercial courtesy to obey this injunction, and consequently an invoice bearing the purchase order number reaches the factory either before or with the first delivery of material on the order. This first shipment invoice may only partly cover the order. In any case the invoice goes to the purchase agent, who stamps it on its face with rubber-stamp impressions of Forms 3 and 3 A, which see, and fills the first three spaces of Form 3, and the order number spaces in Form 3 A. A single invoice may be divided into allotments to different standing order numbers. After this receipt, price, extension, and standing order certifications by the purchase agent, the invoice goes to the department of plant, where the fourth space of Form 3 is filled from 4 B, and the 5th space of Form 3, "Voucher Number" is also filled. The fourth space of Form 3, "Quantity correct," is filled by department of plant from certification by the receiving clerk, who upon receipt of material compares it with his blue triplicate Form 4 B, and if the order is completely filled, makes and signs a certification of quantity and condition on Form 4 B, and then sends it to the department of plant. In case the material received only partly covers the order, then the receiving clerk notes this receipt of material on Form B, and makes a statement of receipt on Form 10, interdepartment correspondence blank, a plain bond-paper sheet 7¾ by 5 inches headed "Subject ...." "To ....," and forwards Form 10 to the purchase agent, who notes receipt of material on his yellow Form 4 A, and then sends Form 10, bearing the receiving clerk's "Materials Received" and signature, rubber-stamp impression, to the department of plant.

The receiving clerk, after noting the partial receipt of the order on his blue Form 4 B, returns it to his "waiting" tray, and holds it there until he receives material to satisfy the order fully, before sending Form 4 B to the purchase agent, and, through the purchase agent, to the department of plant. Thus the department of plant is informed by the nature of the form used for communication from the stores receiving clerk as to whether the materials received wholly or only partially satisfy the order number which is borne by the invoice. If the delivery is partial, then the Form 10 bearing the order number is filed with the Form 2 bearing the number, in department of plant cabinet drawer marked "Unfilled Orders," and held there until blue Form 4 B of that purchase order number is received from the receiving clerk, thus certifying the complete receipt of the order by the stores room. The notifications on Form 10 are compared with the invoices bearing that order number, and everything being found correct, the department of plant sends the invoice to the cashier.

So far the factory is safe, as it has the ordered material under lock and key. The factory is also fully informed, since every official who should know the story of the order has a full written history of the transaction. The stores keeper made the order notification or requisition to the department of plant on Form 2; the head vitalized, and finally filed it in his cabinet. The purchase agent on authority and transcription from Form 2, wrote the letter ordering shipment from vendor, at the same time making carbon duplicate and triplicate with the one writing, the original being the letter sent away, the yellow duplicate being the purchase agent's own filed story of the order, while the blue triplicate goes to the stores receiving clerk, and is filed in the stores room, where the transaction began its record on Form 2. It will be observed that each human factor in this complex act of purchase ordering holds a copy of the work for which he was mainly responsible, and that while only two form originals have been filled, the vendor has been advised as to shipment, and four functionaries of the factory hold written histories of the transaction in detail. All of this is admirable; nothing wasted, and records filed in factory departments wherever useful.

The purchase voucher is made out on Form 6. This form is filled by the cashier from invoices received from head of department of plant; the invoice is then filed alphabetically in the unpaid invoice file in the cashier's room. Each vendor has an individual Form 6 filled for each month, and a check is made each month to satisfy the totals, the check being printed with "In payment of Voucher No.," followed by a space filled with the Form 6 number. If this check is cashed the account is satisfied. (See advices at foot of Form 6 A.) Form 6 is totaled and dated at the end of each month and placed on the unpaid file. Where invoices are paid oftener than monthly, to obtain early payment discounts, a separate voucher is made for each due date and check, covering invoices from date of last check. Checks are drawn to satisfy unpaid invoices at stated periods, or at order of head of department of plant, who alone signs checks.

When Form 6 is filled down to the certification space, it is sent by the cashier with invoice or invoices to the office manager, whose desk is in the department of plant, who compares the filling with the invoice totals, and certifies correctness by his signature, returns invoice or invoices to the cashier, and sends the certified Form 6 to the head of department of plant, who authorizes the drawing of a check to cover, by writing his signature in the "Approved" space, and then returns Form 6 to the cashier, who writes the check and sends check

PURCHASE VOUCHER	Nsme	Account No.
No.	Address	Date Issued

Dates	Amounts	Deductions	Dates	Amounts	Deductions	Account Distribution		
						a/c Nos.	Account Titles	Amounts

I certify that the above account is correct, and that the amount is vouched for by invoices regularly approved by the duly authorized persons.

Office Manager

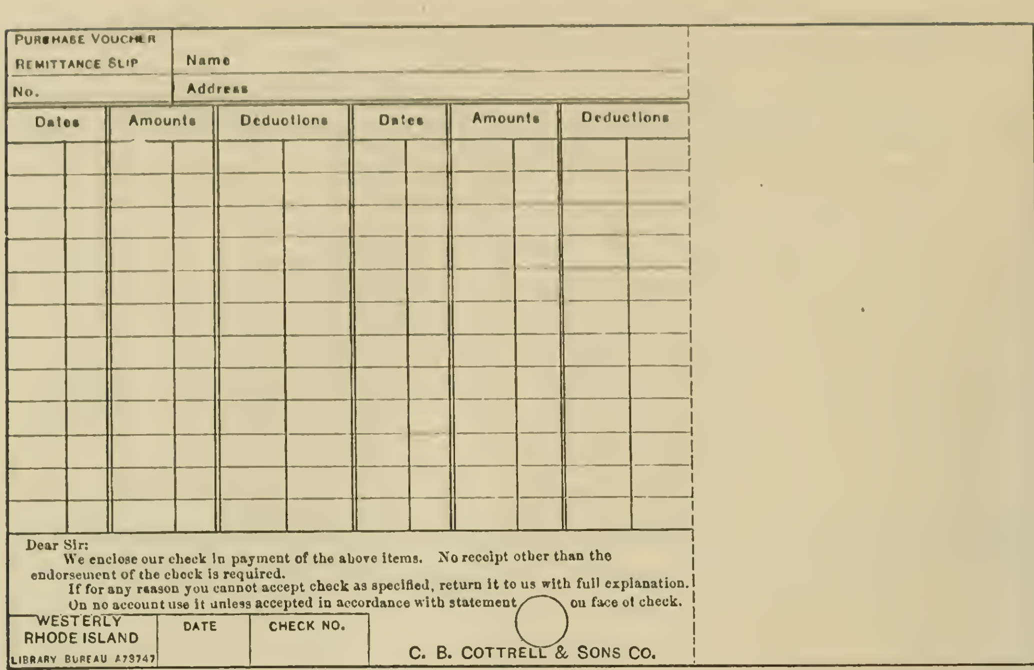
	Date Paid	Check No.	LIBRARY BUREAU A73747	Approved
				Treasurer

FORM 6. PURCHASE VOUCHER.

7¾ by 4¾ inches. Ruled in red and blue and printed in black.

and voucher to the department of plant, where the head signs the check. Then Form 6 and the check are returned to the cashier, who applies the "check-protector" stamp "Not over" the nearest $10 excess, to prevent check raising, and the check then goes with Form 6 A to the mailing clerk. When Form 6, approved, and the invoice or invoices, are returned to the cashier from the department of plant, the cashier stamps the invoice or invoices "Paid" with a rubber dating stamp, and files the invoice by the "vertical file" system, which keeps each firm's correspondence separate. Form 6 A is finally filed alphabetically in a "Paid Voucher" tray, in the cashier's room for reference as required.

While it takes a great deal of space to show these purchase and purchase payment forms, and to specify exactly all of their functions and resting places, temporary and permanent, the forms themselves are very small and simple, and very easily filled by clerks of ordinary qualifications. No one person can alone perform any of the important functions of purchase order and payment. Several persons must be informed, and join their efforts to order material delivered to the factory, and the issuing of a check must also be the work of several persons, including the two of greatest responsibility, the head of department of plant, and the general office manager. Of the two, the purchase is less complicated than the payment; this is commercially



Purchase Voucher
Remittance Slip
No.
Name
Address

Dates	Amounts	Deductions	Dates	Amounts	Deductions

Dear Sir:
We enclose our check in payment of the above items. No receipt other than the endorsement of the check is required.
If for any reason you cannot accept check as specified, return it to us with full explanation.
On no account use it unless accepted in accordance with statement on face of check.

Westerly Rhode Island	Date	Check No.	C. B. Cottrell & Sons Co.

Library Bureau A79747

FORM 6 A. PURCHASE VOUCHER REMITTANCE SLIP.

7¾ by 4¾ inches, ruled in red and blue and printed in black. Filled by carbon copy when Form 6 is made out, and filed with Form 6 in cashier's tray marked "Purchase Vouchers Unpaid" until date of check drawing. It is then sent by cashier to mailing clerk; he forwards it to payee, first detaching, at the perforated line, the right-hand portion containing account details which do not concern the receiver of the check.

correct, as receiving is less hazardous than disbursement. So far as clerical labor expenditure goes, it is difficult to find a detail where the slightest saving is possible.

No literary ability is required anywhere; there is no letter to be written; all that is needed is the careful filling of blanks in printed forms, and the correct transfer of items furnished, and correct addition by use, in the Cottrell offices, of the comptometer, of which there are two in the cashier's office.

Not only is it difficult to see how the purchase and payment labor could be diminished, but it is not at all easy to see how disbursement could be more fully safe-guarded, and made more certainly impossible without concerted action by several different persons; because even granting a combination to defraud the factory by fictitious entries, no matter where made, discovery of the wrong would be certain and soon. The forms shown are especially adapted to the manufacture of the Cottrell printing presses, but, in substantially the same forms and with exactly the same uses and functions, this purchase and payment organization may be said to be the standard for thoroughly systematized practice.

FOUNDRY MANAGEMENT IN THE NEW CENTURY.

By Robert Buchanan.

VII. THE QUALITIES AND TRAINING OF THE FOUNDRY MANAGER.

With this article Mr. Buchanan closes a group of papers which, beginning in December last, have covered the field of foundry management. The topics, in the order of their presentation, have been:—the general arrangement of the foundry, heating and ventilation, and the supply of tools and minor plant; crane service for the foundry floor; moulding by hand and machine; the specification and purchase of supplies; the management of the cupola; and the dressing of castings. This concluding review is particularly noteworthy for its sound statement of a policy toward the question of wages and work which must in the end prevail with both employers and employees.—The Editors.

THE foundry manager will often find himself called upon to advise as to the reason for certain matters having occurred by which castings are faulty or, perhaps, waste. He is fortunate if his men look up to him as being the most skilful man in the foundry, and hardly anything so gains the respect of men as superior skill. There is only one thing higher than skill, and that is character. The proof of good management is supplied by the machine-like regularity of production. This regularity of production should be accompanied by a gradual decrease of costs, though such decrease may be a declining ratio as the larger and more obvious wastages are eliminated. Where, as is sometimes possible, one can introduce methods by which costs are decreased and the earnings of the men increased, it is a very fortunate condition of matters. Decreasing costs by breaking prices, without compensation of another sort, such as improved methods or new tools, is usually evidence of poverty of resources.

The system under which payment is made for work done in the foundry is naturally of the greatest importance. Piece work, when fairly and justly applied (as with a few exceptions it may be said to be) has produced results superior to those of day work, both as regards low costs and the effect on the men themselves.

Efforts have been made, not quite successfully, to introduce the premium system of payment into the foundry. Employers who have seen it accepted by engineers are chagrined to find it rejected by the moulders. The latter are remarkably conservative in all that concerns them, whether it be trade operations or conditions of employment. There is the ever-present fear that changes brought about by forces or agencies external to themselves cannot possibly be designed to benefit them. It may be admitted at once that the benefitting of workmen pecuniarily is not usually the first object when bringing about changes in modes of work or mode of payment. The first object in view is reduction of cost. Paradoxical as it may appear, it is only by reduction of costs that higher wages are made possible. The best friend to those who live by work, whether of brain or hands, or both, is the man who makes a business pay. Where the business is slackly conducted, discipline lax, and waste of time and material rampant, it is only a question of time when the workers have to go seeking work from those who know how to make it profitable. Seeing this is so, what is the objection to the premium system in foundries? Simply that the organisation of foundries generally is deficient. The workmen know it, and do not choose to take risks under such conditions.

The working conditions of a foundry are exceedingly complex, and if a premium system of payment is to have any chance of adoption and permanence, the particular operations to be done by the moulder must be clearly defined and adhered to by both the contracting parties.

The difficulty of drafting such a scheme is not insuperable, and the solution will necessarily be along the lines of having moulders simply doing moulders' work, it being a matter of agreement whether that includes such matters as the filling of sand into his own moulding box, emptying the castings, watering and mixing the sand, mixing facing sand, etc. The actual ramming and finishing and casting of the mould must be the work of the moulder. In some foundries the casting is done for the moulders, but unless under very special conditions, such a course is not advisable. No man is so competent to pour a mould as the man who made it. Mouding boxes (flasks) in proper working condition and as well suited to the pattern as the resources of the establishment can supply should be provided ready to his hand for the moulder's use. The well-equipped foundry would thus benefit from its outlay in providing suitable plant; the badly equipped would have to pay a higher moulding price if the plant be scanty or unsuitable.

There is little use of employers thinking that by a premium or any other system something is going to be got for nothing. What is possible—not only possible, but highly desirable—is the drawing out of the highest capabilities of the men by a knowledge on their part that brain power, experience, bodily strength, deftness of eye and hand.

shall meet with their due monetary reward. Any course of action which seeks to secure the extended exercise of the qualities mentioned without payment for the same, could result only in a speedy drift back to the position left. On the other hand, it is time that trade associations ceased bolstering up the inefficient or slow worker at the expense of the skilful and able. That the unions are of least benefit to the able workman is a truism, and is recognised as such by members of the unions. It follows that the lower grade of skilled labour benefits at the expense of the higher.

It is well to recognise that there is no power in heaven, or on earth, or under the earth can ultimately save the mediocre man from the penalties which attach to mediocrity. Attempts to carry him at a higher level of remuneration than his mediocrity deserves are like as if one carried a large stone all day, just to shew that the law of gravitation did not apply as regards that stone. Night comes, however, and the arms are weary and gravitation is as powerful as when the task was begun. It is as immoral to overpay as to underpay.

It is highly desirable that a basis of agreement shall speedily be found by which the best qualities of the men may be drawn out to the fullest extent and rewarded accordingly.

Before such an agreement can be made there must be a give-and-take by both parties. The unions must consent to greater and unretarded exercise, by the individual, of the high qualities which it is gladly admitted many workmen possess, with the inducement of permanently increased earnings set before him. Be good enough to note the word "permanently," as on that depends the success of any endeavour to draw out the best effects of the men. Unless there is permanence of reward there can be no permanence of effort, and it is foolishness to expect it to be otherwise.

We may be pretty well certain that were the men assured of this permanence of reward, there would be a very different response made than that which we have noted when efforts were made to draw them out.

One contributing cause by which good management may be obtained is a regular system of balancing or checking of the cost of the output at short periods. The ever-present consciousness that mistakes or bad management will inevitably be found out at the end of a month or quarter has a considerable retarding effect on erratic or badly judged changes. To some minds a far-away reckoning has only a slightly deterrent effect. Few minds, however, can look with equanimity for an early date when awkward explanations are necessary. Thus, short-date balancings are of value in checking dubious courses, or extravagances in any direction, and so tend to good management. Responsibility of the individual for results is imperative. Where the operations form only a part of and are mixed up with those of other departments, it is impossible to have the same zest, initiative, and carefulness, which obtain where an individual is responsible for bad management or gets the credit for good. On the other hand, there is sometimes a tendency to reduce or contract the powers of the foundry manager without decreasing his responsibility. All are not in the favourable position of the performer, who, though swathed in ropes, can perform wonders, and yet it appears sometimes as if such a feat were expected to be not only possible to the foundry manager, but easy. Checks, rules, and regulations are a necessity, but when they descend to a system of "red-tapeism" they have become an evil. It is to be guarded against that instead of doing work people spend their time in talking or writing about it.

Training of Apprentices.—As the future of the trade of foundry works depend on the number and quality of the apprentices, their training requires more attention than it is presently receiving. The way in which the apprentice is too often exploited by being kept at one class of work because he does it well and cheaply, restricts the ultimate usefulness of the man to the industry and makes it well nigh impossible for such an one ever to get beyond the mere drudgery of the business. The trade unions endeavour to restrict the number of apprentices, and too many employers unwillingly aid and abet them in the same direction by following the course indicated. What can be the quality of workman turned out by a foundry having amongst its rules one which declares that any apprentice seen upon the cupola platform would be fined? The killing of the goose that laid the golden eggs was a sane proceeding compared with that which kills the legitimate and praiseworthy curiosity of the lad who wants to know all that it is possible to know about the business by which he is to live and make his way in the world, and by so doing prove a source of profit to those employing him.

We are now in a period of rules and regulations which say to the apprentice, thou shalt not do this; thou shalt not do that; and we enter his shortcomings in books and damn him, sans ceremony. It is time we began a constructive period for apprentices. The foundry manager who sets himself to the duty of properly training his apprentices builds for himself a lasting monument in the skill and character of the workman he turns out.

The Training of the Foundry Manager.—The foundry manager who is in demand, a rapidly decreasing demand, is one combining a thorough knowledge of foundry operations with at least a fair knowledge of science so far as it affects his work. In considering the training necessary to produce an efficient foundry manager it is well to remember that undoubtedly the present is a time of transitions. As in so many businesses the requirements daily increase, in number and intensity. The efficient foundry manager of today ought to equal the foundry manager of a quickly perishing period in knowledge of ordinary foundry processes, but in addition he must know something of the causations, physical and chemical, which underlie these processes. It is a debated point whether practical work or technical knowledge should be acquired first. I am of opinion that the best results are obtainable when a good knowledge of practical iron founding has first been obtained, and to that is added technical knowledge, bearing on the subject. Young men are more and more in request for the highest responsibilities, and concentration of work and study is the only way by which they may adequately fulfill the requirements. It would be foolish to claim that we know all the laws brought into play in the course of production. It is still more foolish to neglect to use those which are knowable. Some of us have had the privilege of working with, or have been under the influence of, foundrymen whom it was a privilege to know. It is hopeless to think of excelling some of these in the knowledge of practical work which they possessed. We are fortunate if we can equal them in this respect and at the same time graft upon practical knowledge a scientific insight, which was hid from them. To him who takes scientific work first, the practical work taught in technical colleges, however complete the curriculum and equipment of the college may be, can only be introductory to the more serious training of the foundry which exists by reason of its being able to meet any competition. There only may be learnt the great art of handling men effectively, and self-reliance acquired from successful control of work on a large scale. Young men who have first gone through university or technical college classes are very apt to think that with their superior theoretical knowledge they can go into a foundry, keep themselves apart from the workmen as something superior, and yet acquire a practical knowledge of the business. They never make a greater mistake. The workmen are the custodians of the accumulated practical experience of a century, and they impart their knowledge only to those who win their confidence.

The man with scientific training is wanted in the foundry, but only if he can produce results superior to those of the man who is practical and nothing else.

That the foundryman of today needs all the aid which science can give him is not a sentimental opinion. The fact is not to be gainsaid that engineers are year by year adding to their demands for more excellent and reliable materials. Time was, and that not so very long ago, when specifications required test bars 2 inches by 1 inch supported at two points 36 inches apart to sustain without breaking a strain of 28 hundred weights, applied at the middle of the bar. Most iron founders thought they were doing very well when they met the requirements stated. Now when engineers are demanding that 30 hundred weights be applied at the middle of a similar bar, without fracture, what are iron founders going to do to meet the demand? To meet it successfully they themselves must either have a thorough knowledge of the mixing of metals or they must depend upon such knowledge in others. The latter position requires the purchase of irons already mixed suitable for the purpose, and this costs money. The one who knows how to mix metals such as will give the tests required, is in a very much more advantageous position as regards cost of production, and orders inevitably gravitate to those who produce cheaply, and not only promise, but fulfill, high tests.

Those who have studied most the problems which present themselves in foundry work are most aware that the solution of these problems is anything but obvious in most cases. Here there is room for the most powerful mind, the brightest intellect, for as yet we are looking only on the surface of things and much of value lies hidden below.

EDITORIAL COMMENT

THE scheme for the thousand-ton barge canal from the Lakes to the Hudson, just at its present stage, bears a strong resemblance to the Nicaragua Canal scheme at the time when THE ENGINEERING MAGAZINE first took up the fight for the best route for an Isthmian Canal. There is no more question that a waterway must be built from the Great Lakes to the sea than that the world's commerce must be given a quick and direct passage across the American isthmus. But it is far more clear that the particular project which the people of the State of New York are asked to adopt and pay for does not meet any of the requirements. It is almost the most expensive and least efficient that could be devised, and worst of all, has been so conceived deliberately in the protection or furtherance of certain selfish interests which short-sightedly think to fatten at the public expense. The object and intention has been to limit the use of the canal to vessels which cannot navigate the Lakes, and hence to secure to Buffalo the "profits" of the trans-shipment of every ton of cargo from Lake carriers to canal barges.

Engineering News, quoting from an able report by Mr. Wm. Pierson Judson, draws an instructive comparison between the proposed inland route and the possible route *via* the Niagara River and Lake Ontario. The latter could be opened many years earlier, and (with temporary use of the Welland Canal) at barely half the cost. In its entirety, it would save largely in maintenance cost and in time of transit for vessels, by the inclusion of 195 miles of open-water navigation. *Engineer News* well says that "every conside tion of sound business principles a common sense would indicate that t route should be built upon" in pref ence to adopting the $101,000,c scheme with which the politicians ha hoped to stampede the people.

We should go further yet. It dc not need a very distant vision to s the necessity for a channel from t Lakes to the sea large enough to gi safe passage to full-sized cargo stea ers. With the present-day rapidity movement in commerce and indust that necessity will almost certainly pressingly felt long before the wat way can be opened. Any project whi is adopted should have in ultim view the extension to a regular sl canal. And on the inland route this practically impossible.

* * *

THE whole industrial world seems have been seized with the strike ma ness. On every side we hear of lal wars and rumors of labor wars, a there are those who take the grav view of the situation. We are not pessimistic, though it may well be mitted that in certain lines—the bui ing trades, for instance—activity is at all likely to be resumed on the sa scale, and the check given by the lal agitators may very probably me into a long depression of which t strikes will have been the precipitati though not the only, cause.

But in the main, the very viole and general outbreaking of the trou may serve to force a more serious tention than has heretofore been giv to its characteristics and its removal—or at least its reduction. The settlements effected are likely, we believe, to be dictated less by expediency and more by a just appreciation of the fundamental principles involved. Some few ruling decisions will be established which will go a long way toward lessening future contest. The public, the employer, and the employee will all get clearer views on certain points which they have heretofore seen "through a glass, darkly."

One of these—and to many it will appear the most salient—is with regard to violence. With discouraging slowness, no doubt, but (we believe) with certainty, there is crystallizing a public repudiation of the methods of brutality which have so often marked—and do yet so often mark—the efforts of strikers to carry their point. This repudiation is extending not only to the leaders who permit, but to the public officers who do not suppress, the disorder. There is a gradually growing perception that the striker who assaults a "strike breaker" is no more of a hero and no less a criminal than the grocer who dynamites his competitor's store—that union violence and intimidation are exactly on a plane with White Cap outrages, or Molly Maguirism, or the atrocities of the Ku Klux, or any other attempt to set up a nonlegal system of rules of conduct and to enforce it by violent invasion of the life, liberty, and property rights of the individual who does not bow to the artificial code of the organization.

There is another point where labor will make a little progress toward wisdom—a very little, but some—and that is in the direction of understanding what things the legitimate power of organization can be exerted to secure. In resistance to oppression, in redressing of real grievances, in bettering the market for labor and in securing the highest market price for it, in association for mutual protection and improvement—in these and many other estimable objects, legitimately pursued, labor organizations have unquestionable right and ample scope to occupy themselves. But when they attempt to deny and prevent individual freedom in the purchase and sale of labor they will fail, because they are running counter to the immutable laws of justice; and when they attempt to fix a meagre limit to a man's productive effort and refuse him the right to pass these artificial bounds, they will fail, because they are running counter to the fundamental principles of economy and the laws of natural development. If such tactics could succeed, they would bring all society first to stagnation and then to rapid decline; but they will not succeed so long as Nature continues to implant the principle of growth in every living organism. It is hard to say which impression is uppermost—of the absurdity, the pitifulness, or the stupidity of the little labor councils, looking back over the progress of the past half-century and the men and policies that have made it, and then trying to regulate the future by cramping the spirit and genius of every worker within the confines set by the least ambitious or most slothful of them all.

As to the employer, the thing which has grown clearer is that the right of organization belongs to labor, and that exasperating and intolerable as many of its present manifestations are, it holds some of the most promising possibilities for a greater future stability. The unions cannot be "smashed." That effort is as hopeless as it is unjustifiable. They must be dealt with—not according to their own often distorted ideas, but with fair reason and common sense so far as these can prevail, and with firmness supported by the strength of employers' organizations where their education needs the rod.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

TECHNICAL EDUCATION IN AMERICA.

THE TRAINING OF ENGINEERS IN THE UNITED STATES AS VIEWED BY BRITISH AND AMERICAN ENGINEERS.

Prof. W. E. Dalby—Mr. J. A. L. Waddell.

LAST year Professor W. E. Dalby made a visit to the United States at the instance of Mr. A. F. Yarrow, to study the methods of technical training there in vogue, together with the relations of such training to the subsequent active participation of the students in engineering work. The result now appears in an interesting paper presented by Professor Dalby before the meeting of the Institution of Naval Architects, which evoked an instructive discussion. At the outset Professor Dalby stated that the general opinion in the United States is that an engineering training must include a college course, and the apprenticeship rules are generally framed in full recognition of this principle, the men passing without difficulty from the college to the works. He therefore examines the subject from both the standpoint of the technical educator and of the employers and works managers.

So far as the question of general technical education goes, the paper presents in a clearly tabulated form the nature and extent of the work done at certain typical American colleges, those selected being Harvard, Yale, Columbia, and the Massachusetts Institute of Technology. Professor Dalby states that these are among the highest institutions in the United States, although there are many more of practically equal standing from a technical point of view.

The principal features of interest brought out by this portion of the paper are the wide latitude permitted to the student in his selection of a course, coupled with a very definite amount of standard instruction. In general, a technical education in the United States really means four years of continuous hard work at a college fully equipped with engineering laboratories and workshops and with all the appliances and educational apparatus for giving a scientific education.

Taking the colleges named, the tuition fees range from £30 to £40 per year, while the actual cost of the student to the college is much more than the amount of the fees which he pays. Thus, at the Massachusetts Institute of Technology the average cost per student is £59, of which each student pays on an average only £35. In general, the fees paid by the student represent only about one-half of the total income of the institutions, the balance being made up from income on endowments, state and municipal grants, and gifts from private individuals.

The portion of Professor Dalby's paper, however, which is of the most immediate interest, is that which relates to the manner in which the students in the United States pass almost immediately into the workshops of the country and become at the same time producers and wage earners, completing their scientific education by practical hard work in the shop.

It is now generally recognized by employers in America that a man with a technical training makes a better apprentice and develops into a better officer than a man with only an ordinary education. As a result, nearly all the technical colleges find that their graduates are in immediate demand, and it is not infrequently the case that the applications from employers for technically trained young men exceed the entire number of available members of the graduating class.

In most instances the young men enter the establishments under a regular system of apprenticeship, and Professor Dalby gives as typical examples of these systems those of the Pennsylvania Railroad Company and the Baldwin Locomotive Works. The principal point about these systems is that they recognize that the technically trained man is far more apt at learning shop methods than the less scientifically trained ordinary apprentice, a special classification being made for them, giving them ample opportunities to learn and to make themselves more and more useful and valuable. No premiums are paid to the firm by any of the apprentices, and substantial pay is given at once, rising according to a pre-arranged scale based on the period of service.

As Professor Dalby says:

"Generally speaking, the attitude of the American employer towards the college graduate is one of distinct encouragement, and of advantage to both. The employer gets the advantage of a trained intellect and the employee gets the advantage of his employer's shops and business experience. The American employer keeps an 'open door' for the technically trained man, whilst with us in England the door is too often closed by rules regarding age and the like, and the would-be apprentice not having sufficient means to pay a premium in addition to the amount he has already paid for his education. In cases where college graduates are taken on in England, they are, as a rule, expected to go through the same course as a boy entering straight from school. The Americans are more yielding in this respect, and do not insist upon the drudgery of the first few years.

"Whether the American system would succeed in England is an open question. The conditions in this country are somewhat different. I venture to think, however, that if employers would carefully consider the question in relation to the future of engineering in this country, there would result a greater co-operation between them and our technical colleges. The rules of apprenticeship would be altered so that the technically trained man would find an opening, and in this way employers would provide the opportunity, without which the best man has no way of showing his genius."

In the course of the discussion upon Professor Dalby's paper, Mr. Yarrow made some very pertinent remarks, especially calling attention to the fact that a mere technical education does not necessarily make a competent engineer. Success of men at college only indicates that they made good students, and it does not in the least degree prove that they have any aptitude for the engineering profession—that they are clever with their hands, that they have the power to control men, or that they have any inventive faculty. It does not follow that a scientific man will make an engineer, but in these days, to occupy an important post, an engineer must be a scientific man. Mr. Yarrow also presented a scheme to be adopted in the works of his firm at Poplar, for the admission of technically trained apprentices without premium, practically on similar lines to the systems in use in the United States.

In this connection it is interesting to glance at some features in American engineering education, as viewed by an eminent civil engineer. In an address to engineering students, Mr. J. A. L. Waddell threw some lights upon the value of a scientific training as it appears to the technically trained engineer after he has been in practice for many years, and has found out just what relation his education has borne to his work.

Thus the idea that it takes the brilliant student to become a good engineer is often erroneous. Many a slow-thinking student, who may have just succeeded in passing the examinations, has become a successful engineer, while it is well known that many of the finest mathematicians who graduate from the technical schools are never heard from afterwards in the engineering world.

So far as the question of premium is concerned, Mr. Waddell says that the young man should be content to work at first for little or nothing, and calls attention to the fact that in England premiums are required, but he mentions the fact that some engineers are getting rather tired of having young men in the office as pupils who leave just about as they are beginning to make themselves really useful.

The active interest which is being manifested in the close connection between technical training and practical enginering development is most important, and there is little doubt that the future is the brightest for that nation which develops to the maximum the applied science of engineering as related to its manufacturing and technical industries.

RECENT DEVELOPMENTS IN RADIOACTIVITY.

THE SPONTANEOUS DISENGAGEMENT OF HEAT BY THE SALTS OF RADIUM—THEORIES AND EXPLANATIONS.

MM. Curie and Laborde—Comptes Rendus.

THERE has been much inaccurate talk of late concerning the properties of the radioactive elements isolated and studied especially in France by Mme. and M. Curie, M. Laborde, M. Debierne, and others, and hence the recent paper of MM. Curie and Laborde in the *Comptes Rendus* of the French Academy is to be welcomed as giving an authoritative account of the facts which have thus far been discovered.

There appears to be no doubt that the metal radium and its salts do emit heat in a continuous manner. In their experiments MM. Curie and Laborde arranged a thermoelectric couple, the junctions of which were enclosed in small bulbs, these in turn being carefully insulated from external heat. Into one of the bulbs was placed a gramme of radiferous barium chloride, containing about one-sixth of its weight of pure radium chloride, while in the other bulb was placed a gramme of pure barium chloride. A difference in temperature of 1.5° C. was observed between the two bulbs, the one containing the radiferous salt having the higher temperature. The result was checked by filling both bulbs with pure barium chloride, when practically no difference in temperature was observed.

The amount of heat emitted was determined quantitatively by causing the bulb containing the radium to impart its heat for a given time to a block of metal. A similar elevation in temperature was subsequently produced in the same block by means of an electric current of known intensity heating a wire of known resistance, and the energy disengaged was found to be about 14 gramme-calories per hour. Owing to some uncertainty as to the precise amount of radium in the salt with which the experiments were made, it is not certain just how much heat would be emitted by pure radium, but it may be closely approximated to about 100 gramme-calories per hour emitted by one gramme of radium.

It is impossible to explain the disengagement of this quantity of heat upon the hypothesis of any ordinary chemical transformation. If it is due to any internal transformation of the substance this transformation must be of a more profound nature, and may be due to a modification of the radium atom itself. If so, it takes place with extreme slowness. The properties of radium do not appear to undergo any appreciable change under a close examination, lasting over several years. Spectroscopic examinations made by Demarçay with an interval of five months upon the same specimen of radium chloride showed no appreciable variation. For these reasons the explanation of this disengagement of heat is being sought in other directions, and it is thought possible that some external energy of an unknown nature is thus transformed.

In discussing this subject in a recent communication to *The Times,* Sir William Crookes shows that there is a large amount of energy locked up in the molecular motions of quiescent air at ordinary pressure and temperature, and refers to the fact that as long ago as 1898 he suggested that radioactive bodies might draw upon this store of energy. The atomic structure of radiant bodies may be such as to enable them to throw off the slow-moving molecules of air with little exchange of energy, while the quick-moving missiles are arrested, with their energy reduced and that of the target correspondingly increased. The energy thus gained by the radioactive body would raise its temperature, while the surrounding air would become cooler.

Although the fact of emission of heat by radium is in itself sufficiently remarkable, this heat is probably only a small portion of the energy radium is constantly sending into space. It is at the same time hurling off material particles which reveal their impact on a screen by luminous scintillations. Stop these by a glass or mica screen and torrents of Röntgen rays still pour out from a few milligrammes of radium salt, in quantity to exhibit to a company all the phenomena of Röntgen rays, and with energy enough to produce a nasty blister on the flesh, if kept near it for an hour.

In a paper recently presented before the Royal Society, and published in the *Electrician,* Sir William Crookes discusses in general the emanations from radium, and emphasizes especially the peculiar manner in which they cohere to almost everything with which they come in contact. Thus filters, beakers, and dishes used in the laboratory for operations with radium, after having been washed in the usual way, remain radioactive, a piece of blende screen held inside the beaker or other vessel immediately glowing with the presence of radium.

Sir William Crookes describes a number of experiments made with the crystalline residue obtained by evaporating to dryness a solution of radium nitrate. The crystals themselves were but feebly luminous, but a number of interesting effects were obtained by the use of a screen of Sidot's hexagonal blende (zinc sulphide), this becoming phosphorescent when approached to the radium, the effect lasting from a few minutes to half an hour or more, according to the strength of the initial excitement. When a piece of solid radium nitrate was brought near the screen a general phosphorescence was produced, together with brilliant scintillating spots, these spots not being confined to any one position, but appearing rapidly at different points without any apparent movement of translation. A number of curious effects in connection with these scintillations are described, but after all the main feature of interest in all the emanations from radium and its salts lies in the question of origin. Up to the present time no satisfactory explanation has been given for this apparent creation of energy, and yet it is impossible to assume that the heat and light effects, and the Röntgen rays, are produced in contradiction to the laws of the correlation of force and the conservation of energy.

The hypothesis of Professor Crookes, noticed above, that the radium simply acts as a medium for dissociating energy from the atmosphere may be correct, and in answer to a query as to the fact that this view would involve the suspension of action in a vacuum, the reply is made that what is ordinarily called a vacuum is very far from being such in the sense in which these actions are understood.

The highest vacuum which it would be possible to produce would still contain ample matter to comply with the hypothesis of Sir William Crookes, and in default of a better explanation of the action of radium it is probable that his views will at least form a guide for further experimental investigations.

THE NATIONAL PHYSICAL LABORATORY.

AN ADDRESS BY DR. GLAZEBROOK UPON ITS RELATIONS TO ENGINEERING AND THE SOLUTION OF PRACTICAL PROBLEMS.

Institution of Mechanical Engineers.

In an interesting lecture recently delivered before the graduates of the Institution of Mechanical Engineers, the Director of the National Physical Laboratory, Dr. R. T. Glazebrook, F. R. S., gave an account of the relations of that institution to engineering, with some excellent examples of work already accomplished in that direction.

After a detailed description of the mechanical equipment of the engineering laboratory at Bushey House, new buildings having been constructed for this department. Dr. Glazebrook proceeded to discuss some examples of the work performed, and in so doing he called attention to the fact that the operations might be classified under three heads; namely, routine test work; original investigations undertaken at the request of the engineering committee; and, inquiries and experiments made at the request of engineers and others, and for which fees are received.

Routine test work includes the comparing of standards of length, for which proper comparators are provided; also for the calibration and reproduction of standard screws. An especially well equipped department is that for testing and standardising pressure gauges. A mercury column 50 feet high, provided with a scale graduated into millimetres, pounds per square inch, kilogrammes per square millimetre, and feet of water, has been constructed, a lift enabling the entire length of the column to be readily accessible. This enables pressures up to 300 pounds per square inch to be read directly, while by use of a differential direct-weight testing apparatus pressures up to 8 tons per square inch may be used. The thermometric laboratory is prepared to make accurate comparisons directly with the nitrogen thermometer up to about 900° C., while instruments reading up to 1,300° C. can be accurately standardised by comparison with platinum-rhodium thermo couples.

The laboratory is well equipped for studies in metallography, and sections of rails, girders, and other metallic members can be examined and microphotographs made for record and comparison. At the present time the laboratory is not provided with such a testing machine as should be in such a place. Doubtless much of the testing of materials of construction will always be made at the works of manufacturers, but there should be a means of ultimate reference to an official testing machine of undoubted accuracy, in the hands of disinterested observers, so that disagreements might be cleared up and authoritative records made. In the United States the great Emery testing machine at the Watertown Arsenal has admirably filled this position, and the valuable series of volumes issued by the Ordnance Bureau bears witness to the extent to which it has been used.

In this connection Dr. Glazebrook calls attention to an interesting point which may well be expressed in his own words. Says he:

"Englishmen are conservative; the high-class maker does not want the tests—he knows his products are good; his cheap and nasty rival does not want the tests—they will expose his weaknesses.

"One firm of deservedly high reputation wrote to me a short time back, saying: 'It would never do for us to admit that our goods stood in need of a certificate.'

"Forgive me if I state plainly my opinion that in many cases at any rate the high-class maker is wrong. A certificate such as we can give can only help him and expose his inferiors."

In the line of research work much that is of interest is in progress. Thus the work of the alloys research committee of the Institution of Mechanical Engineers is to be continued at the laboratory, and already much valuable study has been given to the properties of nickel steel and of nickel-manganese steel. These include experiments on the elastic fatigue of metals, a machine now being under construction by means of which stresses of known amount and frequencies up to 1,200 to 1,500 per minute may be applied to a test specimen.

Another most important line of research work is that of wind pressures on engineering structures. These experiments are the outcome of those made by Sir Benjamin Baker at the time of the building of the Forth bridge in 1884, supplemented by the anemometer experiments of Mr. R. H. Curtis at Bidston and Holyhead in 1900. These investigations all consisted in the observation of natural wind pressures, and hence there was no way of checking the accuracy of the work. At the laboratory the wind forces are artificially produced, and hence under definite control, and the pressures and their effects may be accurately and precisely determined. Although the entire apparatus is on a greatly reduced scale from anything in practical work, the wind pressures on actual structures can be calculated with the same kind of accuracy as is obtained from the computation of the actual resistance of a ship from an experiment in a tank.

In regard to the third department of the work of the laboratory, that of making special researches for engineers and others, for which fees are received, this must naturally be a matter of growth as its importance and value are appreciated. Such tests are obviously confidential, and the results are the property of those for whom they are made. At the same time some instances are given in which the results were permitted to be made public, and one of these, a series of tests on a tool steel, is given in detail by Dr. Glazebrook. These included tensile tests, tests of hardness, cutting tests, chemical analyses, and photomicrographic examinations of the structure. The results showed the suitability of the steel for use in making cutting tools, and gave definite information as to the methods to be employed in its use. Before the establishment of the laboratory there was no place in the country where such an investigation could have been conducted on the application of a private individual, while at Bushey all the work, except the original forging of the ingot, was performed on the spot.

Another example of the value of the work done at the laboratory is found in the determination of the specific heat of iron at high temperature. In the measurement of the temperature of a furnace by the use of a mass of iron and a calorimeter it is necessary to know the specific heat of iron, and although this has been known to vary with different temperatures, it had, until recently, not been definitely determined. At the request of a correspondent of the laboratory the subject was investigated, and, according to a new series of experiments made by Dr. Harker, the specific heat of iron has now been accurately determined and plotted on a diagram for temperatures from 300° to 900° C.

The progress of such an institution as the National Physical Laboratory must necessarily be slow at first, but the development of the Reichsanstalt at Berlin has shown what may be accomplished, and when, as has been indicated by Dr. Glazebrook, the immediate value of the laboratory to the engineering profession is appreciated, it will doubtless become an important factor in the development of applied science in Great Britain.

HOLLOW PRESSED AXLES.

THE IMPROVED METHOD OF FORMING RAILWAY AXLES BY PRESSURE AT THE HOMESTEAD STEEL WORKS, PITTSBURG.

Camille Mercader—Iron and Steel Institute.

UP to the present time axles for railway service have been forged under the hammer, and the greatest care has been found necessary to secure a product which will stand the severe drop tests demanded by the specifications. Larger shafts have been produced under the forging press, and by operating with an annular blank the pressure can be exerted upon the interior as well as the exterior, and much better results obtained than by forging solid masses under the hammer. In the case of railway axles the advantages of the hollow form have been appreciated, since in many cases the completed forgings have been bored through from end to end to remove the defects due to segregation and piping of the ingot. In order to secure a higher grade of product, as well as to increase the rate of production, an improved method of manufacture by pressure has been devised by Mr. Camille Mercader, and a description of the process, as carried out at the Homestead Steel Works of the Carnegie Steel Company at Pittsburg, formed the subject of a paper presented by him before the Iron and Steel Institute.

Mr. Mercader's process is almost audacious in its simplicity, and depends almost wholly for its success upon the power and perfection of the machinery by which it is carried out, and a large portion of the paper is devoted to a description of the press and other machinery designed for the work and in use at Homestead.

"A rolled round steel blank, uniformly heated, is inserted into a two-part die, having a matrix cavity in the form of a rough turned axle. The diameter of the journals is made equal to the smallest diameter of the axle in the center, which corresponds to the diameter of the round blank. After the dies are clamped about the heated round the latter is axially perforated simultaneously at both ends by two cylindrical punches, which force the metal of the blank to conform to the shape of the matrix die and fill out the same. The round is heated up to about 1,000° C. and the total hydraulic pressure required for penetration with a punch of 3 inches diameter amounts to about 50 tons. During the last end of the stroke a total hydraulic pressure of about 150 tons is required because the blank loses its initial heat through contact with the dies and because the end collars upset, at which time the metal may flow back against the punch.

"Considering the small diameter to be pierced and the length of the punch, this pressure required to penetrate the blank is, apparently, very small, and it will be conceded by all familiar with the work that a prerequisite to entering the blank lies in allowing the metal to flow freely in the direction of the forward movement of the punch. The presence of the annular spaces between the blank and the die fulfills this condition, the metal flowing radially in the direction of the least resistance; the only back flow against the punch is at the end of the stroke."

In order to enable the metal to flow under the action of the pressure it is necessary that the blank shall be heated to the proper temperature, since the resistance would otherwise become too great. Experiments at Homestead showed that the lower limit is about 850° C., while at 1,050° C. the operation can readily be performed, a pressure of about 150 tons being found sufficient.

In the course of the extensive experiments which have been conducted in the development of the process, a number of interesting facts have been developed. It is most essential that the blank shall be straight when it is placed in the press, since any deviation from the truth causes the punches to bend. The blanks are therefore passed through a straightening machine after leaving the furnace and before entering the press, this machine consisting of a pair of cross rolls arranged to give the blank a rotating, as well as a longitudinal traversing motion, the operation also removing all scale and delivering the blanks to the press not only straight, but also clean and smooth.

Numerous experiments were also made before suitable material for the punches was found. At first water-cooled steel punches were employed, but without great success. Crucible steel punches were tried, but it was found that the point of the punch became welded to the interior of the axle, and when withdrawn it was covered with steel, and was too rough to be used a second time. Finally success was obtained by using punches of high-carbon Bessemer steel, tipped with loose caps of drop-forged steel. The cap being slightly larger in external diameter than the punch, serves to protect it in entering, and since the cap is welded to the bottom of the hole in the blank each time the punch is readily withdrawn. The dies have thus far been made of cast iron, water cooled to prevent change in shape, and good results have been secured, although it is possible that cast steel dies may ultimately be employed.

With the experimental plant erected in Homestead, the time required to make one axle, all operations included, does not exceed two minutes. Allowing, again, two minutes for cleaning and black leading the dies and for cooling and capping the punches, the capacity of one press is 15 axles per hour, or 300 axles, 5½ x 10-inch journal, per 20 hours, which is fully three times the quantity accomplished with one hammer by the best American practice. The number of men required to operate the press remains the same as needed at the hammer to forge five 5½ x 10-inch journal axles per hour.

The advantages of the new method of producing axles by pressure as compared with the old process of forging are numerous. The present axle is of perfect form, necessarily conforming exactly to the interior of the die, and the shape can be best adapted to resist the stresses to which it is subjected with the least amount of metal, and any modification in shape which experience may indicate may be produced by making the proper dies. Since the forging action is carried out throughout the mass of the metal, both internally and externally, the material is found to be far more homogeneous than is the case with solid forged axles, the effects of segregation being entirely destroyed. The axle being as straight as the die in which it is made, no subsequent straightening is required, and the smoothness of the exterior renders it necessary to finish only the journals and the wheel seats, the finishing cost being thus materially reduced. So far as operative cost is concerned, fully three times as many axles can be produced with the same labor cost, while the capacity of existing plants may be proportionally increased by the substitution of the new method for the old.

The weight of a 100,000 pound capacity steel car is decreased by 1.7 per cent., permitting this load, which amounts to 24,000 pounds in a train of 40 steel cars, to be used for other purposes, or a corresponding saving in energy to be made.

Mr. Mercader gives in his paper details of tests of the pressed axles, showing conclusively the high quality of the product, while the density and uniformity of the material is well shown by photo-micrographs of etched sections.

The development of this improved process for making railway axles is an excellent example of the transformation which is being made in modern manufacturing processes. By the use of apparatus of tremendous power and strength, a greatly improved article is made with a reduction of the labor cost to one-third, and the attainment of a higher operative efficiency for the plant.

MECHANICAL RECORDING DEVICES.

METHODS AND APPARATUS FOR THE PRACTICAL INVESTIGATION OF RAPIDLY VARYING PERIODICAL PHENOMENA.

Société des Ingénieurs Civils de France.

MANY of the modern problems of practical engineering involve the use of instruments and methods almost as refined as those formerly found only in the reseaches of the physical laboratory, and the engineer of to-day employs apparatus of much ingenuity and precision.

In a paper published in a recent issue of the *Mémoires de la Société des Ingenieurs Civils de France,* M. E. Hospitalier discusses the modern methods and devices for observing and recording occurrences and phenomena in engineering work, with especial reference to rapid and periodical variations, and some abstract of his article is here given.

In the domain of electrical engineering especially, it has become necessary to deal with rapidly varying phenomena of which the frequency attains a hundred, a thousand, or even ten thousand periods per second, and these facts have resulted in the development of practical industrial methods of investigation of great precision and convenience. Some of these methods are examined in the paper of M. Hospitalier, with details and illustrations of the apparatus.

A rapidly varying phenomenon may be studied by two different methods, using apparatus employing either direct or indirect observation. A direct apparatus must permit the observation or recording of the occurrences instantaneously, without producing any perturbations. Such devices for direct observation are of two kinds. The first involves the use of an apparatus having a very small moment of inertia and a very short period of oscillation compared with that of the phenomenon to be investigated, together with suitable damping devices. The second, especially adapted to the study of variable currents, includes thus far but a single device, the rheograph of M. Abraham, and is practically the opposite of the first method, involving a high moment of inertia and a much longer period of oscillation than that to be examined.

Indirect methods of observation may be considered as based upon the principle of the stroboscope, the periodical phenomena being practically delayed and a greater number of phases collected, many periods being observed together. This is accomplished by having the period of oscillation of the apparatus itself very great with regard to that of the phenomenon observed, while at the same time the duration of the whole of the periods thus gathered is relatively very great. The arcoscope, the ondograph, and the pressiograph are based on this principle.

Among the direct instruments, M. Hospitalier describes at length the oscillograph, this consisting of a very small band of soft iron, so mounted as to be capable of torsional vibration, and bearing a minute mirror of silvered mica, by means of which its movements may be magnified so as to become visible or recordable by photography. A series of uniform vibrations of any desired periodicity for purposes of comparison is also produced mechanically, usually by means of a toothed wheel driven by a synchronous motor. The soft metal band acts in the same manner as a collection of minute magnets placed at right angles to its axis of torsion, and under the influence of varying electrical forces it responds promptly and proportionally.

The manograph of Hospitalier and Carpentier is another example of a direct instrument, and one of especial interest to the engineer, since it corresponds in its action to the indicator, so modified that it is capable of application to engines of such high speed as the small internal-combustion motors of automobile vehicles, when exposed to the shocks of actual service.

This device consists of a minute mirror mounted on three points placed at the corners of a right-angled triangle, with spring supports, thus being capable of movements about two axes at right angles to each other. The pressure in the cylinder is conveyed to the mirror through a flexible diaphragm in such a manner as to cause it to oscillate about the horizontal axis, while the movement of the motor shaft is conveyed by means of a flexible shaft and gearing to a minute crank shaft, causing the mirror to oscillate about a vertical axis in synchronism with the piston of the motor. A beam of light thrown upon the mirror will then be reflected from it with the resultant of both motions, projecting the indicator diagram upon a screen for visual demonstration, or upon a sensitive plate for photographic record.

M. Hospitalier gives examples of diagrams taken from a De Dion-Bouton motor, taken at 2,200 revolutions per minute, showing most clearly the effects of premature and delayed ignition, and having a far smoother and more satisfactory outline than those taken with the ordinary indicator from slow-moving steam engines.

The indirect, or stroboscopic, method is also discussed by M. Hospitalier, and its advantages shown for many cases. The general principle of the stroboscopic methods may well be shown by considering the example of simple uniform rotation. Suppose a rapidly revolving wheel in a dark room. If a flash of light is thrown upon it it will be seen for an instant. If successive flashes are made at intervals exactly corresponding to each revolution, the wheel will always be seen in the same position, and will appear to be standing still. If the flashes occur at slightly closer intervals than the rotations of the wheel, the latter will appear to be moving slowly backward, while if the flashes are slower than the revolutions the wheel will seem to be moving forward. The actual speed of rotation of the wheel may thus be visually retarded in a proportion depending entirely upon the rate of the successive illuminations. The same is true of any moving object, however irregular its motions, since it may be caused apparently to stand still or to perform its motions at any rate of speed determined by the frequency of the intervals of illumination. The lighting may be most conveniently effected by permitting the rays from any source to pass through slits in a revolving disc, since this enables the frequency to be controlled at will, giving opportunity to observe all the movements of the object under investigation, or to cause it to stand still in any desired position or period.

The wide scope of this method will at once be appreciated, and M. Hospitalier enumerates but a few of the devices which have been made involving its use. Thus by means of the arcoscope the variations in illumination of an arc produced by an alternating surrent may be observed, however high the frequency. By use of the ondograph the form and sequence of the waves of alternating electrical currents may be recorded and studied; while with the pressiograph the variations in pressure of high-speed thermal motors may be examined. These and other applications are discussed in M. Hospitalier's paper, and the ingenuity in the details of these devices, due to the efforts of many physicists of note, will afford many suggestions for the design of other special devices upon similar principles.

There is little doubt that the extending use of such methods and apparatus will do much to broaden the scope of engineering work and to increase the appreciation of exact quantitative processes in actual practice. The vast improvement in the steam engine which has followed the popularization of the indicator is an instance of the benefits which result from the use of accurate scientific methods in engineering work, and similar consequences should follow the employment of these later appliances.

SUPERHEATED STEAM FOR TURBINES.

A STUDY OF THE ADVANTAGES AND DISADVANTAGES OF SUPERHEATED STEAM IN TURBINES OF THE DE LAVAL TYPE.

E. Lewicki—Verein Deutscher Ingenieure.

FOR a long time the theoretical advantages of superheated steam have been fully realized, and it has been only the practical difficulties connected with its use in engines of the piston and cylinder type which have prevented its general use. Fully fifty years ago a number of important vessels were fitted with superheaters, among them the Great Eastern, but at the present time no vessel of importance is so provided, notwithstanding all the efforts which are being made to insure high steam economy. The principal difficulty experienced with the use of superheated steam lies in the action of the rubbing surfaces, including the effect of the high temperature upon the lubricant, and hence, when the seam turbine was introduced, it was realized that a machine in which there was no rubbing contact should be well adapted for use with steam at a temperature which would be impracticable in existing engines. At the same time it was understood that the greatest advantage to be expected from the use of superheated steam lay, not in the moderate increase in expansive force due to the higher temperature, but rather in the reduction in cylinder condensation. Since the conditions which conduce to cylinder condensation, such as the admission of live steam into a space from which cooler exhaust steam has just been discharged, do not exist in the case of the steam turbine, it has been a question as to whether any marked increase in economy was to be expected by superheating the steam, and the matter has therefore been left to experiment for determination. A series of important trials upon a turbine of the De Laval type has recently been conducted in the mechanical laboratory of the technical high school at Dresden, and the results are embodied in a contribution to the *Zeitschrift des Vereines Deutscher Ingenieure* by Herr Ernst Lewicki, from which we make some abstract.

The tests have been made during the past two years, upon a 30 horse-power De Laval turbine in the laboratory at Dresden, where facilities were available for experimenting with steam of 500° C. superheat, using a Schmidt superheater, as well as appliances for measuring power, temperatures, and water. Steam was supplied from a Schmidt boiler, and the consumption was accurately determined by condensing all the steam which passed through the turbine. Heat losses were provided against as fully as practicable by jacketing the apparatus, and the gauges and other instruments were compared and calibrated especially for the trials.

The turbine, built by the Humboldt Works, at Kalk, near Cologne, was arranged to be run at a speed of 20,000 revolutions per minute, reduced by gearing to 2,000 revolutions of the shaft upon which the brake was placed; and the machine was operated by steam of a pressure of 6 kilogrammes per square centimetre (about 85 pounds per square inch), and when exhausting against the pressure of the atmosphere it was rated to develop 30 horse power.

The measurement of the temperature of superheating, most important in this connection, was made by the use of a Le Chatelier pyrometer, immersed in an oil bath placed in the steam pipe close to the entrance of the steam into the turbine nozzles, and the calibration showed that the probable error in the temperature determination did not exceed 2½ per cent., the readings being taken for every 5° C. The revolutions were taken by a system of gearing forming a positive counter, and a tachometer was also attached to the second shaft, the speed determinations having a probable error of only 0.25 per cent.

An interesting feature of the tests is found in the use of nozzles of different materials and forms, experiments having been made both with diverging and with converging nozzles, using bronze and steel as materials. The precise dimensions of the nozzles are tabulated in the report, as well as other valuable data relating to the machine.

In conducting the investigations a certain number of definite questions were proposed and the answers sought by actual trial, and the results are conveniently presented in that form in the original paper. Broadly the results of the trials demonstrate that a marked economy in steam consumption is attained.

Thus, when operating with steam at 85 pounds pressure, the steam consumption with saturated steam, when developing 21.4 horse-power was 21.6 kilogrammes per horse-power hour, or about 47 pounds. With steam superheated to 460° C., the power increased to 24.5 horse-power, and the consumption per brake horse-power per hour fell to 14.1 kilogrammes, or 31.8 pounds. At full load the gain was equally marked; the steam consumption with saturated steam, with a development of 44.1 horse-power, being 17.7 kilogrammes, and with steam superheated to 500° C. falling to 11.5 kilogrammes, or 38.8 pounds and 23.5 pounds respectively, per brake horse-power hour.

The experiments with various nozzles showed that the diverging nozzle, as proportioned by the designers of the De Laval turbine, gives better results than the converging nozzle, and is evidently based upon correct theoretical principles. For superheated steam, however, it was found advantageous to substitute steel for bronze for the nozzles.

An interesting feature of the tests was the determination of the frictional resistance to the movement of the wheel opposed by saturated steam and steam of various degrees of superheat. This was measured by driving the turbine wheel by an electric motor and measuring the power required to keep it in motion when the case was filled with the respective fluids. Thus, to maintain the wheel at 20,000 revolutions in air it required 4.6 horse-power, while in saturated steam at atmospheric pressure but 3.3 horse-power were needed. At 184° C. superheat the power to drive the wheel fell to 2.25 horse-power, while in steam superheated 300° C., only 1.88 horse-power were required.

One source of loss in connection with the use of superheated steam was the high temperature of the exhaust steam, the exhaust when the incoming steam was at 500° C. leaving at a temperature of 343° C. A method for utilizing this loss in a practical manner is suggested by Herr Lewicki, this being in principle a form of regenerator. If the hot exhaust steam is led off so as to surround the incoming live steam after it has left the boiler and before it enters the superheater, much of the heat will be made available for the preliminary portion of the superheating, the actual loss thus being made very small.

The entire report is the most complete mass of information concerning the use of superheated steam with the turbine which has yet been made public, and the accuracy with which the work was done and the precision with which the results are recorded render this a valuable contribution to modern steam engineering.

CONSULTING ENGINEERS AND THEIR WORK.

INAUGURAL ADDRESS TO THE STUDENTS OF THE CITY AND GUILDS CENTRAL TECHNICAL COLLEGE.

Dr. A. B. W. Kennedy—Engineering.

IN the inaugural address recently delivered by Dr. Alexander B. W. Kennedy at the Central Technical College, and published in *Engineering*, some very excellent advice is given, primarily to the students to whom the address was directly delivered, and also generally to members of the profession and others who will gladly profit by Dr. Kennedy's experience and judgment.

Dr. Kennedy first called attention to the two broad divisions in the profession, which may be called manufacturing engineering and consulting engineering, and confined his discussion mainly to the work of the latter class. In so doing he showed that there was no occasion to make any comparison between the two classes, both, in his opinion, being absolutely essential and both equally dignified. In fact, it is almost necessary for a consulting engineer to have had practical experience in the works of manufacturers in order that he may know the difficulties which are to be encountered in the execution of works subsequently designed by himself. With consulting engineers may also be grouped the great army of borough engineers, of engineers to municipal works of every kind, and of engineers to companies or firms who are not manufacturers.

The main duty of a consulting engineer is the formulation of what may be called "schemes." A corporation wants a water supply, or a gas works, or a company wants a big manufactory, a railway, or a bridge, or a design may be required for a tramway or other power house, or for an electrical transmission scheme. The engineer in such a case has not himself to design machinery, nor generally to design the details of anything, although he may have to design a general scheme of very great complication. Here, however, comes in a department of work which is not generally thought of in connection with engineering; that is, the financial side of the question. The consulting engineer must not only be able to estimate the cost of the work which he has laid out, but he must decide between the relative value of several schemes, and consider their financial relation to the undertaking of which they form only a part.

"The question as to whether a thing will pay is influenced by a great many conditions. It is influenced first by the immediate cost, which is not a very serious matter to arrive at by estimating. A much more difficult question is to arrive at the conclusion whether certain variations, certain improvements, or certain alterations, which will cost money, will yield a profit if carried out."

It is in this department of the work of the engineer that his best and most careful judgment must be exercised. As an engineer, he may readily be able to decide which of two methods is the better one, but the question is not always one of mechanical performance, but one of ultimate monetary advantage.

Thus it is well known that a condensing engine uses less fuel than one in which the exhaust steam is allowed to blow off into the atmosphere, and it is also settled that there is a decided economy in the use of superheated steam. At the same time the use of condensing engines is involved in the access to an abundant supply of water, or in the additional cost of cooling towers and accessories, and these vary in different localities. The gain by superheating may be far overcome by the cost of the apparatus and its attendance, and in nearly every instance there are local considerations which should be taken into account. As a well-known engineer in the United States once tersely put it, it is the economy of money and not the economy of steam, which the owner desires to secure. These are only illustrations of the fact that the consulting engineer must be at the same time an engineer and an economist in the broad meaning of the term, if he is to make a success of his profession.

Dr. Kennedy discusses the question of specifications in a very broad and liberal spirit. Too much detail should be avoided, as tending to take responsibility out of the manufacturer's hands, and cause needless expense to the client. At the same time the work to be done should be so clearly indicated that the various contractors may fully understand what is required of them. Anything unusual and original should be so fully described that there may be no difficulty about knowing how it is to be carried out, and no uncertainty exhibited as to the engineer's idea and meaning. If the work of certain contractors is especially desired it should be so stated, and others not put to the trouble of preparing tenders which are certain not to be accepted. The engineer, however, must not let himself be persuaded by a manufacturer that a thing cannot be done, when he himself believes that it can be accomplished. A manufacturer's evidence that a thing can be done is often final, at least if he has already done it; a manufacturer's evidence that a thing cannot be done is purely negative evidence; it merely means that he does not know how to do it.

The important subject of supervision and inspection naturally comes in for a share of the discussion. Here much difficulty may be avoided by having had a clear and definite specification. In all cases, however, questions will arise in which the engineer must hold the position of arbitrator between his clients and the manufacturers. He has first to see that his employers get what he has specified, while, on the other hand, he should see that the contractors are fairly dealt with. Questions of delays from unforeseen and unavoidable causes may occur, entitling the contractors to consideration, while, on the other hand, there will be occasions when absolute compliance with the conditions of the specification must be enforced. The position of the engineer should always be that of absolute justice to both sides, notwithstanding the fact that one side is his own client.

From the very nature of his occupation the consulting engineer is in a position to acquire a large and varied experience which places him in a position to know more about methods and machines than some of the manufacturers themselves. Each manufacturer knows all about his own work, but not so much about the work of other makers, and hence the consulting engineer, while always open to receive information, is usually in a position to state positively why and how a thing should be done. There are always many ways in which a thing can be done, and it is never wise to try to make a manufacturer alter details of his own merely to satisfy a personal fad. Far better to take advantage of all the knowledge and experience of the contractors who are carrying out the work, and be ready to add to this all the additional experience which has already been acquired.

Professor Kennedy adds some wise words as to the ethics of the profession, which, while they are at bottom only the precepts of common honesty, sometimes need just such a clear statement as he gives them, and thus he concludes an address filled with the wisdom of a ripe experience.

THE "KAISER WILHELM II."

THE LATEST ADDITION TO THE TRANSATLANTIC FLEET—THE LONGEST AND MOST HEAVILY POWERED SHIP IN THE WORLD.

Scientific American—The Nautical Gazette.

IN a review of modern transatlantic steamships, which appeared in these columns at the time of the launch of the "Kaiser Wilhelm II.," a brief account of her was given, and she was compared with some of the other great liners, but the completion of her first trip across the ocean furnishes an occasion for a more detailed description.

In her general appearance she is similar to her predecessors in the North German Lloyd, the "Kaiser Wilhelm der Grosse" and the "Kronprinz Wilhelm," and to the "Deutschland" of the Hamburg line, all of which were built at the Vulcan yard, in Stettin. She has the four buff funnels of the other big German liners, but carries three masts instead of two. When seen alone, her great length is not so striking, as her upper works are very high, and her lines are symmetrical and graceful. Her size is best realized when on board of her, particularly when one gets into a position where there is a clear view up and down the decks.

According to figures given in the *Scientific American* and *The Nautical Gazette,* the dimensions of the "Kaiser Wilhelm II." are: Length, 706 feet, 6 inches; beam, 72 feet; molded depth, 52 feet, 6 inches; load draft, 29 feet; and displacement, about 26,000 tons. The double bottom, which extends the full length of the ship, is divided into twenty-six compartments, while the hull itself is divided into nineteen watertight compartments. There are seven decks, known respectively as the orlop, lower, main, upper, lower promenade deck, upper promenade deck, and awning or boat deck. The vessel thus carries one more deck than is common in large passenger ships of her type, her predecessors having only one instead of two promenade decks; and by the way, these two decks are truly magnificent in their clear, unobstructed sweep from the bridge to within a short distance of the taffrail. To those passengers who spend most of their time on deck, the doubling of the promenade deck accommodation will be a great convenience. The passenger accommodation includes 290 first-class cabins and 107 second-class, and one of the show features of the ship is her two "imperial" suites, each of which includes a dining-room, drawing-room, bedroom, and bathroom, all most daintily and tastefully decorated. There are also eight suites that include sitting-room, bedroom and bathroom, and also eight state cabins with bathroom adjoining. The most spacious room in the ship is the first-class saloon, a magnificent room, 69 feet broad and 108 feet long, which provides sitting accommodations for 554 passengers. The second-class saloon accommodates 190 passengers. The four kitchens, the largest of which is about 55 feet by 30, can cater to about 800 first-class passengers, 400 second-class, and 1,100 third-class, besides the crew, which numbers about 600 individuals, the engine- and boiler-room complement alone being 237. The actual number of passengers to be carried, however, will be limited to the seating capacity of the saloons.

There are many different apartments for the general use of the first-cabin passengers, all fitted up, in tasteful and luxurious style, with every convenience. Among these rooms may be mentioned a typewriting room, adjoining the library and reading-room, a safe deposit room, where passengers can secure private safes for storing their valuables, a children's room, gaily decorated with paintings representing the principal characters in Grimm's fairy tales, a coffee-room for non-smokers, an open-air smoking apartment, besides the regular smoking-room, drawing-room, and ladies' room, with which other first-class liners are provided. There is a post-office on board, with several postal officials in charge, and the mails will be sorted during the passage and landed at the port of arrival, ready for immediate delivery. The ship is also equipped with a wireless telegraph apparatus.

The bulkheads which divide the ship into compartments have watertight doors, which can be closed by a hydraulic system operated from the bridge, and in the wheel-house there is a board with small incandescent lamps which show whether the watertight doors are open or shut. The vessel is, of course, completely lighted by electricity; there are electric heaters in the staterooms, and there is a telephone central station which puts the staterooms and all other parts of the ship in immediate communication with each other.

The engine-room is made up of four separate compartments, divided by longitudinal and transverse bulkheads, with a complete engine in each, balanced on the Yarrow-Schlick-Tweedy system. There are two propeller shafts, and two engines are arranged in tandem on each, a stuffing-box coupling being used on the crank-shaft where it passes through the transverse watertight bulkhead separating each pair of engines. This arrangement is novel on transatlantic liners, although it has been adopted on some warships, as, for instance, the United States armored cruisers "New York" and "Brooklyn." On these latter, however, the after engines alone were used for cruising, and the forward engines were supposed to be coupled up when the maximum speed was needed. As a matter of fact, when the emergency arose, at the battle of Santiago, more time would have been lost in coupling up than gained by the increased power, and so the forward engines were never used during that historic engagement.

On the "Kaiser Wilhelm II.," the engine in each compartment is a complete quadruple-expansion, four-cylinder unit, and its contract indicated horse power, as given out by the company, is 10,000, although it will undoubtedly prove to be greater when the engines have found themselves. This is shown by a comparison between the engines of the "Kaiser Wilhelm II." and those of the "Deutschland." The engine on each shaft of the "Deutschland" consists of two 36.6-inch high-pressure cylinders, one 73.6 first intermediate, one 103.9 second intermediate, and two low-pressure cylinders 106.3 inches in diameter, the common stroke being 72.8 inches. On each shaft of the "Kaiser Wilhelm II." there are two 37.5-inch high-pressure cylinders, two 50-inch first intermediates, two 75-inch second intermediates, and two 112.2 low-pressure cylinders, their common stroke being 70.8 inches. The steam pressure in both cases is the same, 213 pounds to the square inch. Now, the engines of the "Deutschland" have always indicated much more than contract power, the greatest average for the whole trip being 37,500 or 4,500 more than the contract. The contract calls for 40,000 horse power in the "Kaiser Wilhelm II." and probably toward the close of the season she will be averaging considerably above this, and her speed may run as high as 23.75 or 24 knots an hour.

There are two propellers, each 22 feet 10 inches in diameter. The driving shaft is 230 feet long and weighs 253 tons, the weight of the crank-shaft alone being 108 tons 15 hundredweight. To condense the huge volumes of steam that are delivered to the condensers requires 46½ miles of condenser tubes. The vessel has nineteen boilers, twelve of which are double ended and weigh, when empty, 114 tons apiece. The total heating surface of these boilers is over 2½ acres. The coal bunkers have a maximum capacity of 5,239 long tons of coal, and the coal consumption is about 650 tons per day. For bringing the coal from the bunkers to the furnaces, there is a narrow-gauge railroad track 200 yards long.

The dynamo-room is situated abaft the engine compartments, the generators being direct driven by their own engines and grouped between the propeller shafts, which pass through the compartment. On board the ship there are seventeen powerful steam pumps, capable of raising over 2,000,000 gallons per hour. The anchors weigh 23½ tons, and the chain cables and hawsers are over a mile in length.

Such is an outline of some of the features of this truly remarkable vessel. After inspecting her one is tempted to say, in the first flush of enthusiasm, that she is pretty near the superior limit of naval architecture and marine engineering, but it is always dangerous to prophesy, and perhaps before the "Kaiser Wilhelm II." is much older, another record breaker will appear on the seas. But she will have to be a good one.

ALCOHOL MOTORS.

DATA AND RESULTS OF TESTS MADE AT THE EXPERIMENTAL STATION OF THE EXHIBITION OF 1902, AT PARIS.

Max Ringelmann—Revue de Mécanique.

WE have already referred in these columns to the developments in the use of alcohol as a source of light, heat, and motive power, as indicated by recent investigations in France, and now we have an elaborate discussion by M. Max Ringelmann of the tests made upon internal-combusion motors using alcohol as fuel during the competition following the exhibition of 1901, and held in the Grand Palais des Champs Elysées in 1902. This paper, which is published in the *Revue des Mécanique,* examines principally the performances of stationary motors, together with those intended for portable use, giving curves showing comparative performances, and also discusses generally the subject of the commercial availability of alcohol as a fuel for power purposes, a question at present widely considered on the continent.

The principal object of these tests, and indeed of the entire exposition, was to demonstrate the practicability of using alcohol as a fuel, and to indicate the most efficient methods by which it may be employed, the purpose being to aid in developing a national industry of much importance. The trials were made with two varieties of fuel, one being pure alcohol "denaturé," or simply rendered unfit for human consumption by the addition of a slight amount of benzine, or similar substance, and the other being an alcohol combined with 50 per cent. of hydrocarbon, usually benzine or coal-tar naphtha. According to the computations based on chemical analysis, the pure alcohol has a calorific value of 5,521 calories per kilogramme, while the carburetted alcohol has a value of 7,453 calories per kilogramme, the former thus having but 74 per cent. of the value of the latter, but at the same time being but 80 per cent. of the cost. The results of a number of tests of motors with both fuels showed that the consumption of carburetted alcohol for the same power generated was about 70 per cent. of the consumption of pure alcohol, and that figure was therefore used in the tests in reducing to a comparable basis the performance of motors employing the two fuels.

The trials which form the basis of the paper of M. Ringelmann were made upon 42 motors representing 25 different makers, practically all of the better known French builders of internal-combustion motors, as well as some from Germany and Switzerland. The modifications necessary to enable the alcohol fuel to be used are principally in details of mixture, compression, and ignition of the charge, and hence this permitted existing patterns to be used to a great extent. These machines were divided into classes according to the power developed and also according to the weight per horse-power developed. Nearly all the motors exhibited and tested were for stationary service, but a few were of the portable type, capable of being transported from place to place, and adapted for operating pumps, threshing machines, dynamos, etc.

The stationary motors varied in size from 1 to 35 horse-power, the greater number ranging from 5 to 10 horse-power, single and double-cylinder machines being represented, ignition being effected both by electricity and by the hot tube. In the original paper the tests are tabulated in full by groups, showing the performance both with pure alcohol and with the 50 per cent. carburetted mixture, the collected results being given graphically as well. For these details the reader must be referred to the article of M. Ringelmann, but the general conclusions may be given here to some extent.

The earlier trials of internal-combustion motors using alcohol showed that the machines operating at high rotative speeds, as arranged for use with automobiles and launches, were more economical than the larger and slower stationary engines. For this reason the motors were tested in groups, according to size, this rendering the results more readily comparable. In several instances the motors were constructed with variable compression, in order that the best proportion might be attained experimentally, although the results of such variations do not appear in the records of the trials.

When the mixed alcohol and benzine fuel was used, the motors were started as readily as in the case of the ordinary gasoline motors, but with the pure alcohol it was found desirable to use the mixed fuel for starting, and to have the connections so arranged that the heat of the exhaust pipe warmed the incoming charge.

When such motors are well designed and operated there is little or no odor produced in the discharge gases, the regulation is fairly uniform, and there is no fouling of the valves. When, however, the air supply is excessive, or the carburetting is imperfect, incomplete combustion follows, while excessive pressure or temperature is liable to produce a decomposition of the alcohol, causing the formation of various products, such as acetic aldehyde, ethane, acetic acid, methane, naphthaline and rarely formaline. More or less acetic acid is always found in the exhaust, and is liable to corrode the valves and valve-seat, and hence it is desirable to inject a small quantity of oil when the motor is left standing.

The most important element in alcohol motors lies in the carburetter, since the proper relation must be maintained between the volume of air admitted and the carburetting surface in order to secure the constant proportion of the charge. There is manifest room for improvement in this portion of the apparatus, since with the different carburetters of even the best makers, quite variable results were experienced. It must be understood that the liquids are not gasified, there really being formed a mixture of combustible vapors of varying tensions, frequently containing liquids in a state of pulverisation.

The tests included researches into the proper proportion of air to produce the best effects, and according to the analyses of M. Sorel, by whom this portion of the work was conducted, the highest economy was attained by the admission of about 50 per cent. excess air over that theoretically required for the complete combustion of the total carbon in the charge. If this proportion of air is diminished the proportion of unburned carbon in the exhaust increases very rapidly, this point being of much importance in connection with the economical performance of the motor.

In general the consumption of alcohol, carburetted with 50 per cent. of benzine, ranged from 0.233 kilogrammes per horse-power hour, to 0.645 kilogrammes, the mean being 0.433 kilogrammes, the price of the fuel being 0.468 franc per kilogramme in Paris.

From this it will be seen that the cost of a horse-power for a working year of 3,000 hours will average 607.9 francs, which compares favorably with the cost of power developed by steam engines of like dimensions.

The attention which is being given to the subject of the utilization of alcohol as a fuel for motive power is indicated by the exhaustive character of these tests, and the information derived from them should also aid in the improvement of the internal combustion motor in general.

PROGRESS IN ELECTROCHEMISTRY.

AN ADDRESS ON THE PRESENT STATE OF ELECTROCHEMISTRY AND THE CONDITIONS FOR ITS FURTHER PROGRESS.

Joseph W. Richards—American Electrochemical Society.

THE science and the art of electrochemistry have made such great advances of late years, and in America its practical applications in particular have increased so largely, that the rapid growth and the marked prosperity of the American Electrochemical Society, which have been already commented upon in these columns, while subjects of congratulation, are not to be wondered at.

It is, therefore, in a justly optimistic spirit that Prof. J. W. Richards, at the third general meeting of the American Electrochemical Society, recently held in New York, delivered his presidential address on the conditions which make for progress in science in general and electrochemistry in particular.

Science advances in many different ways, along many different paths and by many different agencies, but for the purposes of his discussion he classifies this progress under six headings: 1. Discovery of new facts. 2. Clearer understanding of the laws correlating facts. 3. More rational theories of the why and wherefore. 4. Increasing application of the facts to the welfare of mankind. 5. Increasing dissemination of scientific literature. 6. An increasing vision, on the part of the scientist, of the possibilities of scientific achievement.

The discovery of new facts may be regarded as the corner stone of progress in electrochemical, as in every other science. Given a freshly flowing current of new electrochemical facts, all the other elements of progress are vitalized. The birthplaces of these facts are the chemical, physical and electrical laboratories of universities, industrial corporations and individuals, and the sponsors are the investigators—professors, students, employees and individual seekers after knowledge. The elect among these workers are the professors of electrochemistry provided with well-equipped electrochemical laboratories. They are in a position to make or to direct the most valuable investigations, and the labors of such workers, given to the world in their publications, form the body of electrochemical science.

The German-speaking countries alone count up at their universities and technical schools fifteen chairs of electrochemistry and twelve electrochemical laboratories, and these have been the source of the greater part of the advance in electrochemical science in recent years. While America has been actively engaged in the development of electrochemical industries, there has not been so much work done in the purely scientific branches, but in place of professors and college laboratories, this country possesses another class of investigators who are no less industrious in acquiring facts and to whom a large part of America's commercial success is directly ascribable. These are the men in the laboratories of our industrial plants, who are searching over ground not yet explored and accumulating facts of value in their special industrial lines. The expense of such work is borne by the corporation for which they labor, and the work itself is in reality an investment made in the hope of yielding financial reward. Such workers frequently discover important facts, but by the nature of their employment they are generally not at liberty to publish their discoveries. Prof. Richards thinks, however, that when such researches have achieved their financial purpose, the scientific results should be given to the world. In other words, when the laboratory experiments have led up to the technical process and the latter has been protected by patents, then the scientific principles discovered during the investigation should be published. As to the when and the how, as well as the extent of such publication, the investigator and his employer are the proper judges, and the matter must be left to their discretion. But if they appreciate as they should the debt which they owe to the science as a whole, they can be safely trusted with deciding the question honestly and fairly to all interested and concerned.

By a careful and systematic study of facts we may learn the so-called laws of a science, which are really concise statements of the procedure of phenomena, or, in other words, scientific laws state briefly that, given certain causes, certain effects will result. Such generalizations may be made by the student and philosopher as well as by the original experimenter, and, in fact, the former is perhaps in a better position to take a broad view of the domain of science than the investigator, who is intensively cultivating only a small part of the field.

As soon as facts are discovered and laws are discerned, the scientist inevitably begins to reflect on the why and the wherefore. He commences to search for relations, to imagine connections and dependencies, and to make pictures of the mechanism of the phenomena. It was thus that Dalton imagined the atomic theory to account for the fact of chemical combination in simple multiple proportions, that Arrhenius hit upon the dissociation theory to account for the increase of molecular conductivity with increasing dilution, that Nernst worked out the solution-pressure theory to explain the generation of current in the galvanic cell.

Such theories are not only allowable, but necessary. They help us to handle mental conceptions as if they were concrete things, and thus to imagine and discover relations and generalizations which would otherwise be beyond our mental grasp. But if science is to progress, theories must progress, too. Probably all theories have been of some use in their day. But when their day has past, they must be modified to suit new requirements, or they may even have to be discarded altogether. If new facts appear which contradict even our most cherished theories, those theories must give way to the march of progress and be replaced by new ones which harmonize with the facts.

In order not to become a mere code of observed and classified facts, a thing to interest men by its intrinsic perfection, but of no other earthly use, a science must find practical applications which increase the comfort and well-being of mankind. In this respect electrochemistry is by no means lacking, it abounds in notable practical achievements, and electrochemical industries are becoming of greater and greater importance.

A great impetus has been given to this development by the utilization of waterfalls to drive electric machinery, and so furnish an economical source of power. But this question of cheap power may be given undue importance, for while in some processes the cost of power may be three-quarters of the total expense, in others it may be only one-quarter, or less, so that there may well be other considerations which will determine the location of an electrochemical plant. Other things being equal, however, the power question will, of course, be decisive, and for this reason Niagara Falls has become such a great electrochemical center.

But besides falling water, there is another source of cheap power which is widely distributed, but which, in America, has hardly been touched. This is the power which may be developed by the use of blast-furnace gas in gas engines. Prof. Richards estimates that there are thus scattered over the United States, in some of the most flourishing industrial centers, undeveloped powers which aggregate over 1,000,000 horse power, which can be developed at no more cost than the average water-power, and can be generated just at the spots where they can be most favorably utilized, and without any more drain on the country's natural resources than the harnessing of a new water-power, for not a pound of coal more would have to be burned than is used at present.

The industrial advance of electrochemistry is best promoted by the intimate and cordial co-operation of theoretical and practical electrochemists. Such co-operation is found in electrochemical societies and in research companies. These latter organizations, formed explicitly to combine research with practical application, are novelties in the industrial world which have originated with, and are almost peculiar to electrochemistry. They invent, investigate and develop apparatus, methods and processes, and furnish facilities to experimenters whose ideas might otherwise be still-born.

No modern science can progress if it adopts the mediæval custom of the alchemists and carefully guards its knowledge for the exclusive use of the initiated, but there is no lack of scientific literature nowadays. The real difficulty is for any technical man to keep well posted in the literature of even a single branch of science, and it is becoming more and more necessary for scientific and technical literature, whether in the form of books, periodicals or the transactions of societies, to be systematically classified and indexed, so that the seeker for information can get at what he wants without an expensive and exhausting search through great masses of printed matter.

In every field of human endeavor, for the teacher in his classroom, the writer at his table, the editor at his desk, the workman at his labor, the investigator at his task, the chief incentive to happy, productive work is the vision and promise of what may be attained. And so in electrochemistry, whatever brightens that vision and brings nearer the fulfillment of that promise is of the highest value to the science. This is the chief mission of society meetings, which by the free interchange of thought, the sharing of ideas, the communication of insights into the possibilities of science, quicken the enthusiasm and strengthen the spirits of the members, so that they derive fresh courage and inspiration for their life work.

THE CURTIS STEAM TURBINE.

A DISCUSSION OF STEAM TURBINES, WITH SPECIAL REFERENCE TO THEIR ADVANTAGES FOR DRIVING ELECTRIC GENERATORS.

W. L. R. Emmet—American Philosophical Society.

PROBABLY the most important features of steam engineering at the present day are the rapid commercial development of the steam turbine and its largely increasing use as a prime mover for electric generators.

The steam turbine has peculiar advantages for the direct driving of electric mahinery, and it occupies remarkably little space in proportion to its power, a matter which is of increasing importance in central stations for large cities. These and other characteristics have fixed the attention of electrical engineers upon the steam turbine, and its present rapid exploitation is largely due to the efforts of the manufacturers and users of electrical apparatus.

Up to the present time, the most important types of steam turbines have been the De Laval and the Parsons. In the former, the steam jet from a specially designed nozzle is directed against a set of vanes on a disc, to which is imparted a very high rotative velocity. With these extreme rotative speeds, the problem of balancing becomes vital, and it is practically solved by the use of the De Laval flexible shaft, which permits the moving parts to adapt themselves automatically to the axis of rotation. But even the very high speeds of this turbine fall short of the theoretically most efficient velocity, which, as is well known, is one-half of that of the jet of steam impinging upon the wheel, and at the same time, the speeds are too high for dynamos to be driven without intermediate gearing.

In the Parsons turbine slower speeds are secured without loss of efficiency by conducting the steam in an axial direction through a series of vanes arranged in fixed and moving circles alternately. In this way, the steam expands successively and imparts its energy to the moving parts. While this type of turbine has proved very successful for electric generation, and is being extensively used, it has a great multiplicity of parts and requires extreme care in its construction.

Other types and modifications of these forms are being introduced in Europe, and in America the principal newcomer is the Curtis steam turbine, which was invented several years ago, and which has been developed commercially by Mr. Curtis and the engineers of the General Electric Company. This turbine is described in a paper by Mr. W. L. R. Emmet, read recently before the American Philosophical Society, and reprinted in the *Electrical World and Engineer* and other journals.

The Curtis turbine has some of the features of its predecessors, but introduces new ones which, it is claimed, make possible lower speed, less weight, fewer and simpler parts, higher economy, and other advantages.

"Velocity is imparted to the steam in an expanding nozzle so designed as to efficiently convert nearly all the expansive force, between the pressure limits used, into velocity in the steam itself. After leaving the nozzle, the steam passes successively through two or more lines of vanes on the moving element, which are placed alternately with reversed vanes on the stationary element. In passing successively through these moving and stationary elements, the velocity acquired in the nozzle is fractionally abstracted, and largely given up to the moving element. Thus the steam is first thrown against the first set of vanes of the moving element, and then rebounds alternately from moving to stationary vanes until it is brought nearly to rest. By this means a high steam velocity is made to impart motion efficiently to a comparatively slowly moving element. The nozzle is generally made up of many sections adjacent to each other, so that the steam passes to the wheels in a broad belt when all nozzle sections are in flow.

"This process of expansion in nozzle and subsequent abstraction of velocity by successive impacts with wheel vanes is generally repeated two or more times, the devices for each repetition being generally designated as a stage. There may be various numbers of stages and various numbers of lines of moving vanes in each stage. The number of stages and the number of lines of vanes in a stage are governed by the degree of expansion, the peripheral velocity which is desirable or practicable, and by various conditions of mechanical expediency. Generally speaking, lower peripheral speeds entail more stages, more lines of vanes per stage, or both. The general practice is to so divide up the steam expansion that all stages handle about equal parts of the total power of the steam. The losses and leakages of the earlier stages take the form of more heat or more steam for the later stages, and are thus in part regained. Much water of expansion, which might occasion loss by re-evaporation, is drained out of each stage into that which succeeds it.

"The governing is effected by successive closing of nozzles and consequent narrowing of the active steam belt. In the process of governing, the nozzles of the later stages may or may not be opened and closed so as to maintain an adjustment proportional to that of the first stage, which is always the primary source of governing. Some improvement of light load economy may be effected by maintaining a relative adjustment of all nozzles; but in many cases the practical difference in economy is not great, and automatic adjustment of nozzle opening in later stages is dispensed with in the interest of simplicity. In some machines an approximate adjustment is maintained by valves in later stages, which open additional nozzles in response to increase of pressure behind them. These are used as much for limiting the pressures in stage chambers as for maintaining the light load economy.

"One of the most important advantages of the Curtis turbine is the high steam economy which it affords under average conditions of service. This economy is shown by curves of water consumption, which are derived from actual tests of the first commercial machine of this type which was completed. This machine drives a dynamo of 600-kilowatts capacity, and the curves give its performance at 1,500 revolutions per minute, which corresponds to a peripheral velocity of about 420 feet per second. These curves show a very high efficiency at light loads and at overloads as compared with results obtainable from steam engines."

Other curves show the effect upon steam consumption of changes in the steam pressure, the degrees of superheat and in the vacuum, and it appears that the superheat and vacuum curves are straight lines so inclined as to indicate a great benefit in superheating highly and in the use of a high vacuum. Steam turbines are peculiarly fitted to take advantage of these conditions; they have nothing which is injured by high steam temperatures, and they can be so constructed that leakage into the vacuum chamber is rendered impossible. No oil comes into contact with the steam, and, consequently, condensed water can be taken from surface condensers and returned to boilers. The use of surface condensers under such conditions renders unnecessary the introduction of air either in feed or circulating water, and so makes possible a very high vacuum with small air-pumping apparatus.

A 5,000-kilowatt Curtis turbine is soon to be put in operation in Chicago, and it is expected that the variation in its efficiency, from half load to fifty per cent. overload, will not exceed three per cent. These turbines, when combined with an electric generator, are mounted on a vertical shaft, and consequently take up comparatively little floor space. In Mr. Emmet's paper there are illustrations of such a unit and of one of the same capacity, driven by a Corliss engine, in the Manhattan Railway Company's power station. The difference in size is striking, and it is stated that the respective weights of these two units, exclusive of foundation, are in the ratio of 1 to 8, while the saving in foundations is great.

"If the extreme simplicity of the Curtis turbine is considered in combination with these figures and comparisons, it is easy to appreciate that a very great engineering advance has been accomplished. It has been conservatively estimated that engine units, like those in the Manhattan Company's station, can be replaced by turbines like that in Chicago, and that the cost of such replacement can be paid for by saving in operating expenses in three years."

ELECTRIC STATION DEVELOPMENT.

MULTIPLE VERSUS INDEPENDENT OPERATION OF CENTRAL STATIONS, AND ECONOMICAL AND SAFE LIMITS IN THEIR SIZE.

American Institute of Electrical Engineers.

HAS the size of central stations reached its economic limit? This question, in a day of consolidation and aggrandizement, may seem to imply a lack of faith in modern engineering, but it is forced upon one by a recent discussion before the American Institute of Electrical Engineers following the reading of papers by Messrs. H. A. Lardner, Philip Torchio and Peter Junkersfeld.

Mr. Lardner's paper was on the "Economical and Safe Limits in the Size of Central Stations," and in it he discussed broadly the advantages and disadvantages of large central stations, with special reference to the conditions existing in cities of the first rank.

"The system of distribution which must be used, frequently has a direct bearing on the demand for a large station. Where the distribution pressure is low, as in Edison three-wire 120-240 volt systems, there are few if any cities where a sufficient load can be found for a very large station without exceeding the limited zone of economical distribution at this pressure.

"Where this system is in operation we find that the stations are generally of high first cost and too small to be operated economically. The location is necessarily chosen without regard to the water or coal supply, and the load factor is generally very bad, which adds to the expense of operation. As a temporary expedient, at least, rotary converters, transformers and high pressure cables have found a place for connecting together the direct current stations and thus enabling them to exchange power and considerably improve their load factors.

"The next step is to establish a large well-located alternating-current station and feed the rotaries from the machines there installed. This method permits the use of the largest size of generating units and gives their attendant economies, and the demands of the various sections of a city coming at different hours of the day produces a better load factor.

From many tests which have been made on steam engines, it has been found that the steam consumption of properly designed and operated engines of capacities as low as 500 horse power compares very favorably with that of the largest sizes used in central stations.

"That part of the cost of labor for engine operation, which varies with the size, amounts to but a small portion of the total operating expenses; and although the larger the unit, the smaller the item becomes per h.p. hour, it is relatively of little importance, except in very small units."

The necessity for the most economical use of floor space in large cities favors the employment of large units, but as a matter of fact, the floor space per horse power is affected more by the type of engine and the judgment of the designer than by the size of the unit, and with the advent of the steam turbine it becomes possible to nearly double the power of a central station without increasing its dimensions.

The advantages of large central stations may be summed up as follows:

"The location of the station on the one most suitable site for the coal and water supply.

"The reduction of floor space by the use of large units.

"The economy of fuel secured by the use of large generators and engines.

"The economy of labor and general superintendence secured by the use of large units in one building.

"The saving in first cost effected by the installation of a large station with large units.

"The economy of operation secured by serving many sections of a city with different hours of maximum demand from one station, due to the better load factor obtained.

"The installation of a large station presupposes supplying a very large territory from one source, and in order that the coal and water supply may be convenient, the chosen location is generally much farther from the load than when it is divided among several plants. This involves a greater expense for a distribution system, although this may be minimized by the installation of high potential current or by local conditions.

"The economy of floor space by the use of large units will always be an important consideration where land is valuable, but the economy in this direction with the steam turbine may lead the designer of the future to give less consideration to this point.

"It is a question whether there is any saving in the first cost in the installation of very large stations, except in prime movers and generators. The construction of double- and triple-decked boiler rooms, large coal handling apparatus and coal pockets high above the ground, involves heavy expenditures without compensating advantages. It is probable in the case of some large stations in this city that they could have been built to half their capacity as cheaply per unit as to the ultimate size. The size of the units in either case would probably have been the same.

"The principal disadvantage of the very large station is the danger to a system if the disabling of the station leaves the company without a source of power, or takes away a larger portion of its supply than can be cared for by overloading the remaining plants."

While the leading modern central stations are fine examples of careful attention to all features which make them reliable in operation and free from danger of breakdowns or interruptions to service, it is practically impossible to eliminate every weak point, and the larger the station and the greater the district which it serves, the more serious becomes the consequences of any accident.

In Mr. Torchio's paper, he gives a long list of the modern devices employed in generating station, transmission lines and sub-stations to secure safety and reliability of operation. On looking over this formidable array of safeguards, there naturally occurs the question whether the advantages of centralization and of wholesale production of current are not secured at too great a cost in the necessary multiplication and refinement of safety devices to insure continuous operation.

These considerations lead Mr. Junkersfeld to advocate the independent or sectional operation of every central station system, so that if trouble occurs, it may be localized as far as possible. In systems of electric supply for large cities, embodying the latest practice, where high-tension alternating current is generated at the central station, transmitted to "rotary" substations, and thence distributed by mains and service wires, the links between the coal pile and the consumer are enumerated by Mr. Junkersfeld as follows:

"Steam supply. Generator, prime mover and auxiliaries. High-tension transmission lines. Sub-station apparatus. Low-tension feeders. Mains and services."

The causes of trouble in each of these links are discussed, and the necessary precautions to be observed are pointed out, and the conclusion is reached "that considering responsibility for the business and return on investment, every central station system should be designed, if not for independent, at least for sectional operation. In the very large stations, the independent units from coal pile to distributing network, or to rails, should be effectively isolated to make a total shut-down practically impossible. The matter of independent, sectional or multiple operation at different hours of the day or days of the year is entirely one of local conditions, which may change frequently. Great care and constant attention is needed to maintain a fairly uniform and consistent coefficient of reliability on every part of the central station system. Independent and even sectional operation will mean a small sacrifice in operating costs. With a system properly designed, this matter, then, becomes to the central station management a plain business consideration: to take the risk of inferior service and possible shut-down, or to pay a premium in the form of very slight sacrifice in operating costs and thus obtain an additional safeguard for superior service to all such groups of customers as business requirements may demand."

MUNICIPAL ACCOUNTING.

SYSTEM AND UNIFORMITY IN ACCOUNTING AND THE COMPILATION OF STATISTICS THE FOUNDATION OF MUNICIPAL REFORM.

National Municipal League—National Conference for Good City Government.

FOR several years past, factories and other industrial establishments have been overhauling their cost-keeping and accounting systems as they have come to a realizing sense of the fundamental importance of these departments of manufacturing economics, and the commercial, or "production," or "modernizing" engineer has become a well-recognized institution. It is, therefore, not surprising that the attention of municipal reformers has been directed to the statistical and accounting departments of city administration, and at a recent joint meeting of the National Conference for Good City Government and the National Municipal League this subject of municipal accounting was reported on and discussed at considerable length, and an account of the proceeding has appeared in the *Engineering Record,* from which some extracts are taken.

The report of the committee on "Uniform Municipal Accounting" was presented by Dr. M. Hartwell, city statistician, of Boston. He deplored the fact that statistics in general as published at the present are not of great value, made a strong plea for better statistics in every department, and stated it to be his belief that municipal statistics should begin at home; that they should relate to the object and needs of local administration and be prepared with the primary purpose of enlightening a local public opinion and of serving local authorities as the basis of intelligent action. So long as a city does not know itself it cannot know other cities, nor compare itself with them, nor profit largely by their experience. The sooner our leading cities are led to insist upon having simple and intelligible financial and statistical reports furnished by their own servants for home use, the sooner will the public and official mind become responsive to demands for the adoption of more modern and scientific methods of bookkeeping and housekeeping by all cities; and the sooner will it become possible for the student of municipal affairs and for state and national officials and bureaus to secure from city officials and publications, such information as is usually unattainable now. The immediate prospects for gathering strictly comparable data throughout the wide range of activities common to cities is not brilliant.

Frederick A. Cleveland, Ph.D., of the University of Pennsylvania, outlined the "Chicago Accounting Reform" in part as follows: Within fifty years Chicago grew from a village to a municipality of 2,000,000; it began with a small town organization; as its population and territorial jurisdiction spread, these town governments were incorporated by consolidation rather than by readjustment and reorganization. The city finally came to include more than twenty separate taxing jurisdictions, over which it had little control, and between which there was no well defined method of co-operation. The financial side of the administration became unmanageable and the government in all its activity was crippled.

Investigations lasting several months were made, and it became evident that municipal reform must begin with the accounts, in order to reduce them to such order as to make the data available as a basis for political action and administrative control. A report having been laid before the mayor, an ordinance was drafted and passed authorizing an accounting firm to install a new system of accounts and to supervise its operation during the first year after installation. The features of the new system as set forth by the official report of the controller are as follows:

Uniformity in accounting methods.

Concentration of the accounting in the controller's office.

Collection of all revenues by the city collector.

Daily remittances.

Monthly reports and balances between the controller and all departments.

Monthly financial report of the controller.

Organization of an auditing bureau and of a methodical plan of auditing by officers retained specially for that purpose and independent of all departments.

Accruement of all revenues on the general books of the city, where they will always be evident as obligations due the city and unpaid.

Approval of all contracts and requisitions for supplies by the controller to prevent departments from incurring liabilities in excess of appropriation.

The issuance of all fiscal stationery, forms and receipts, consecutively numbered by the controller, and holding the departments responsible for their use or cancellation.

The use of graduated stubs or carbon receipts to check the collection of money.

The establishment of a complete chain of accounting from the inception of revenue or expense throughout the various branches of the city to the controller's office, where all the accounting is finally centralized.

All departments have been operating under this new system during the past year. The change from the old to the new was accomplished without confusion or detriment administration became unmanageable and the detailed workings of the new system have progressed without friction. It is now evident that the system has proved an advantage to the city government; has improved the efficiency of individual employees, and promoted an intelligent and interested direction of their efforts by departmental heads. The total of decreased expense and increased revenues seem to be close to a million dollars. From the point of view of municipal reform, the new system has laid the foundation for effective administration, and the reports based on this system give to the citizen a well classified digest of financial results, supplemented by schedules in sufficient detail to furnish a comprehensive knowledge of the affairs of the municipality. Taking the new system of accounting as a whole, it is a masterly piece of work; it may be said that Chicago has taken an advanced position worthy of emulation.

Mr. Harvey S. Chase discussed the progress of uniform municipal accounting in Ohio, outlining the steps taken to secure the passage by the Legislature of an act which created a "Bureau of Inspection and Supervision of Public Offices" under the Department of the Auditor of State. The bureau has had no precedent to guide it, for this is the first time that an entire state bookkeeping, including the accounts of large cities, has been overhauled and systematized.

Mr. Chase called attention to several important features of the National League's system, which had been incorporated by the state. The favorable reception which has been given to the bureau's schedule by the officials throughout Ohio has been very gratifying. The reports of the five largest cities of Ohio—Cleveland, Cincinnati, Columbus, Toledo, and Dayton, for the fiscal year 1902, are now nearly completed upon the new schedules. It must be recognized and remembered that the proposition before the bureau in Ohio is a vast one. It comprises not only the reorganization of the accounting and reporting in the cities, but likewise also for villages, townships, counties, school districts, and, in fact, for every taxing body in the state.

THE ENGINEERING INDEX

"THE ENGINEERING INDEX IS THE KEYSTONE OF APPLIED SCIENCE"

The following pages from a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals if the world,—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger division of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arch.

A Small Concrete Arch at West Hartford, Conn. Illustrates and describes a structure built without reinforcement of any kind. 600 w. Eng Rec—April 25, 1903. No. 54791.

Theory and Calculation of the Two-Hinged Spandrel-Braced Arch. Alex. Rice McKim. Presents a method by which the two-hinged arch can be constructed so that the stresses may be calculated with some degree of certainty of their being those of the finished structure. The article follows the lines of investigation developed by Mohr, Winkler and Mueller—Breslau. 4000 w. Eng Rec—April 11, 1903. No. 54688.

Bridge Engineering.

Essentials Necessary for Successful Practice in Bridge Engineering. J. E. Greiner. Extracts from a lecture delivered before the students of Cornell Univ. Emphasizes the need of continued study to keep pace with the times, and considers some points essential to success. 1500 w. Eng News—April 9, 1903. No. 54589.

Construction.

Types and Details of Bridge Construction. Frank W. Skinner. The first of a

We supply copies of these articles. See page 475.

series of illustrated articles presenting types of bridge construction and giving facts of interest in regard to the notable structures. The present article deals with arches. 2000 w. Eng Rec—April 1, 1903. Serial. 1st part. No. 54687.

Drawbridges.

Drawbridge Calculations. Edward Godfrey. Solves the problem by calculation of the deflections. 1300 w. Eng News—April 16, 1903. No. 54699.

Fort Dodge, Iowa.

The Des Moines River Viaduct of the Mason City & Fort Dodge R. R., at Fort Dodge, Iowa. H. C. Keith. A paper before the Iowa Engng. Soc. Describes the construction of a viaduct 2,582 ft. in length, consisting of 38-ft. towers, with 75-ft. suspended spans, and four truss spans of 220 ft. each. Ill. 2700 w. Eng News—April 9, 1903. No. 54587.

Highway Bridge.

A Steel Truss Highway Bridge with Concrete Floor. An illustrated description of a bridge under construction in Portage County, Ohio, of 100-foot span. 1000 w. Eng Rec—April, 25, 1903. No. 54789.

Manhattan Viaduct.

The Manhattan Valley Viaduct of the New York Rapid Transit Railroad. Illustrated detailed description of a viaduct 2174 feet in total length, which reaches from 125th street to 133d street and carries three lines of track. 2500 w. Eng Rec—March 28, 1903. No. 54445.

Newcastle-on-Tyne.

New Railway Bridge Over the Tyne. Illustrations and particulars of a bridge at Newcastle, for the North-Eastern Ry. Co. Caissons are described. 700 w. Engr, Lond—April 10, 1903. No. 54724 A.

Ouachita River, Ark.

The Ouachita River Bridge, Missouri Pacific Railway. Illustrates and describes a structure of interest owing to the range of rise and fall of water. 700 w. Ry Age—April 17, 1903. No. 54747.

Paderno Viaduct.

The Paderno Viaduct, Italy. An illustrated detailed description of one of the most harmoniously-proportioned of iron bridges in Italy, and of its construction. 2000 w. Engr, Lond—April 17, 1903. Serial. 1st part. No. 54952 A.

Quebec.

Anchor Approaches for the Quebec Cantilever. Brief illustrated description of this feature of the great 1800-ft. span cantilever bridge across the St. Lawrence. 600 w. Eng Rec—April 11, 1903. No. 54684.

Reinforced Concrete.

See Civil Engineering, Materials.

CANALS, RIVERS AND HARBORS.

Bizerta.

The Harbor Works at Bizerta and the Arsenal of Sidi-Abdallah (Rapport et Mémoire sur les Travaux du Port de Bizerte et de l'Arsenal de Sidi-Abdallah). Voisin Bey and Jean Hersant. An illustrated description of important harbor works in Tunis, particularly the making of huge concrete blocks, of 5000 tons, in caissons. 7000 w. Bull Soc d'Encouragement—March 31, 1903. No. 54842 G.

Buffalo.

The Buffalo Breakwater System. A brief history of Buffalo harbor and its protective works, with illustrated detailed description of the latest work. 4400 w. Eng Rec—April 4, 1903. No. 54557.

The New Buffalo Harbor Breakwater. Illustrations and particulars of this important engineering work. 1200 w. Sci Am—April 4, 1903. No. 54491.

Champlain-St. Lawrence.

The Projected Lake Champlain and St. Lawrence Ship Canal. E. G. M. Cape. Brief consideration of this project, with a discussion of its effect on freight from the Great Lakes. 900 w. Eng Rec—April 18, 1903. No. 54768.

Dredges.

Combined Bucket and Suction Dredger for Monte Video. An illustrated description of a dredger built for harbor works in progress on behalf of the Government of Uruguay. 1200 w. Engng—April 3, 1903. No. 54657 A.

Niagara River.

Damming the Niagara River at Buffalo. J. H. Massie. Remarks on the report of Maj. Thomas W. Symons favoring the building of a ship canal round the shoals and rapids, the causes of lowering of the water in Lake Erie, and the proposed remedy by damming the river. Ill. 1800 w. Eng Rec—April 18, 1903. No. 54766.

Panama Canal.

The Panama Canal. Continued discussion of paper bv George S. Morison. 4000 w. Pro Am Soc of Civ Engrs—April, 1903. No. 54972 E.

Pittsburg.

Improved Waterway Necessary for Commercial Outlet. Capt. W. B. Rodgers. A short paper on the need of improving the transportation facilities of Pittsburg, especially the navigation of the river. 1500 w. Pro Engrs Soc of W Penn—Feb., 1903. No. 54963 D.

Pittsburg—Her Waterways and Her Railways. Antes Snyder. Historical review of the development of this city, discussing transportation problems. 17500 w. Pro Engrs Soc of W Penn—Feb., 1903. No. 54962 D.

River Improvement.

The Economic Improvement of the Coosa and Alabama Rivers, in Georgia and Alabama. D. M. Andrews. A discussion of the problems in river improvement, and the best practice from the economic point of view. 3800 w. Pro Am Soc of Civ Engrs—April, 1903. No. 54968 E.

Victoria Falls.

Water Power in South Africa. Francis Fox. Gives an account of the discovery and an illustrated description of Victoria Falls, reviews what has been done at Niagara and at other points in the way of utilizing water power, and considers the electrical development of these falls. 4200 w. Cassier's Mag—April, 1903. No. 54462 B.

Waves.

Tidal Waves, Seaquakes, and Storm Waves. W. H. Wheeler. Considers the causes of abnormal solitary waves and their effects, describing many such disturbances. 4000 w. Engr, Lond—April 17, 1903. No. 54951 A.

CONSTRUCTION.

Chicago Post Office.

The Dome Framing of the Chicago Post-Office Building. Illustrated description of the general details of construction of a steel framework dome 100 ft. in its greatest diameter. 900 w. Eng News—April 23, 1903. No. 54914.

Chimney.

A 165-Foot Concrete Chimney. James D. Schuyler. Illustrates and describes the construction of concrete-steel stacks in Los Angeles, Cal., and in New Jersey and Indiana. 2800 w. Eng Rec—April 11, 1903. No. 54685.

Concrete-Steel Chimney for the Pacific Electric Ry. Co., Los Angeles, Cal. Jas. D. Schuyler. Illustrated description of a notable piece of concrete construction, the erection, materials and method of working. 1700 w. Eng News—April 2, 1903. No. 54551.

Concrete.

Notes on Cement and Concrete Construction in the U. S. Government Fortification Work for 1902. Extracts from the report of the Chief of Engineers, U. S. A., showing devices and methods adopted by army engineers to meet severe requirements. Ill. 4800 w. Eng News—April 2, 1903. No. 54550.

Dams.

Dam Construction and Failures During the Last Thirty Years. C. Baillarge. Gives an analysis of the failures, showing where faulty construction was the cause. 5500 w. Can Soc of Civ Engrs, Adv Proof—March, 1903. No. 54543 D.

Exposition.

Engineering Work on the Louisiana Purchase Exposition at St. Louis. Information obtained during a recent visit of inspection, giving technical details of the engineering work in progress. Ill. 6400 w. Eng News—April 23, 1903. No. 54916.

Fire Prevention.

Fire Prevention and Fire Resistance. Horatio Porter. Considers the means employed for both purposes, their advantages and the difficulties. Also general discussion. 11000 w. Jour Ry Inst of Brit Archts—April 4, 1903. No. 54935 B.

Foundations.

Concrete Pile Foundations of the Hallenbeck Building, New York. An illustrated description of the system adopted for the addition to this building. 1200 w. Eng Rec—April 11, 1903. No. 54686.

Freezing Process.

The Depth of Freezing and the Loss of Cold by Conduction in the Freezing Process of Tunneling. Information given by Mr. Charles Sooysmith, based on records made at a mining shaft sunk at Iron Mt., Mich. 1000 w. Eng News—April 9, 1903. No. 54590.

Manhattan Life Building.

Enlarging and Remodeling the Manhattan Life Building. A description of this interesting engineering work, with illustrated details and methods of carrying out the work. 4800 w. Eng Rec—April 4, 1903. No. 54556.

Philadelphia Subway.

See Street and Electric Railways.

Piles.

Methods and Costs of Pile Pulling and Pile Blasting. Describes methods used, a sweep pile puller, a tripod pile puller, and the blasting out piles. Ill. 2200 w. Eng News—April 16, 1903. No. 54695.

Roads.

A Few Thoughts on Present Practice of Road Construction. James Owen. Considers briefly the construction, materials, practice, etc. 2000 w. Eng. Rec—April 25, 1903. No. 54788.

Massachusetts State Highways. A. B. Fletcher. On the work of the Massachusetts Highway Commission. 1200 w. Eng Rec—April 25, 1903. No. 54795.

New York State Aid Road Laws. An explanation of the Higbie-Armstrong law and the Fuller law. 1600 w. Eng Rec—April 25, 1903. No. 54797.

Road Laws of Illinois. Ira O. Baker. Briefly states the essential features of the laws relating to the construction and care of wagon roads. 2300 w. Eng Rec—April 25, 1903. No. 54794.

State Highway Laws of New Jersey. A

statement of the laws based on reports furnished by Henry I. Budd, the state commissioner of public roads. 2200 w. Eng Rec—April 25, 1903. No. 54796.

The Dirt Road. G. A. Roullier. Considers points often neglected, and gives suggestions for grading and drainage. 1100 w. Eng Rec—April 25, 1903. No. 54790.

The Use of Oil on Roads. Hiram M. Chittenden. From the "Report of the Chief of Engineers for 1902." Suggests points that should be investigated to determine its value, and gives results of its use in California. 1800 w. Eng News—April 23, 1903. No. 54920.

Simplon Tunnel.

The Simplon Tunnel and Its Consequences. Discusses the effect the opening of this line will have on the industrial progress of Italy; considers other engineering works planned, and the increase in traffic probable. 3000 w. Engr, Lond—March 27, 1903. No. 54502 A.

Steel Roads.

Progress of Steel Roads. Gen. Roy Stone. Reports concerning the steel road laid in Murray st., New York, and suggests the construction of automobile roads, and country highways, discussing the advantages of steel. 1300 w. Eng. Rec—April 25, 1903. No. 54799.

Tunnel.

Tunnel at Michel Creek Loop, Crow's Nest Pass Line, Canadian Pacific Ry. C. R. Coutlee. An illustrated account of the construction of a tunnel through loose gravel describing the methods and plant. 3800 w. Eng News—April 2, 1903. No. 54546.

The East Boston Tunnel. Reviews the scheme for rapid transit in Boston, and gives an illustrated description of this work of shield tunneling, now in progress. 3500 w. R R Gaz—April 10, 1903. No. 54591.

MATERIALS.

Cement.

Report of Committee on a Standard Specification for Portland Cement. Gives the specification and testing recommended. 3800 w. Can Soc of Civ Engrs, Adv Proof —Jan. 27, 1903. No. 54709 C.

The Raw Materials Employed and the Amount of Portland Cement Made from Each in the United States. Edwin C. Eckel. Gives a statement based upon very complete data, compiled and tabulated by the author, on the materials and methods at the various plants. 800 w. Eng News —April 16, 1903. No. 54696.

Bending Tests of Small Bars of Cement (Essais de Flexion sur des Barrettes Verticales de Ciment Soumises à un Effort Determinant dans leur Longeur un Moment Fléchissant Constant). L. Deval. An account of cement tests with small vertical bars to determine if breaking by a uniform bending moment is applicable to rapid cement testing. Curves and tables. 1600 w. Bull Soc d'Encouragement—March 31, 1903. No. 54846 G.

Concrete.

Comparative Tests of Limestone and Gravel Screenings and Torpedo Sand for Concrete. G. J. Griesenauer. Gives report of tests the results of which are uniformly in favor of screenings. 1400 w. Eng News—April 16, 1903. No. 54698.

The Use of Concrete in Architecture. David Gibson. Calls attention to some of the uses made of this material, and gives suggestions for its treatment. 1300 w. Munic Engng—April, 1903. No. 54-600 C.

Concrete Beams.

Note on the Coefficient of Elasticity of Concrete and Mortar Beams During Flexure. E. J. McCaustland. Discussion of paper by Myron S. Falk, Jr. 1800 w. Pro Am Soc of Civ Engrs—April, 1903. No. 54971 E.

Fireproofing.

"Ferroinclave," a New Fireproofing. Illustrates and describes a new plant of the Brown Hoisting Machinery Company, in Cleveland, Ohio, using this new material. 1300 w. Ins Engng—April, 1903. No. 54967 C.

Iron Protection.

A Comparison of Various Tests Applied to Paints Used for the Protection of Iron. Augustus H. Gill and Charles C. Johnson. An account of an investigation of the various methods used to test the value of paints, and a comparison of the paints themselves. 1200 w. Tech Quar—March, 1903. No. 54597 E.

Reinforced Concrete.

A Test for Reinforced Concrete (Eine Güteprobe für Eisen-Betan). Fritz v. Emperger. A discussion of tests of reinforced concrete and a plea for their standardization. Diagram and illustrations. 2800 w. Betan & Eisen—2 Heft, 1903. No. 54835 F + H.

Concrete with Transverse Reinforcement Compared with Hooped Reinforced Concrete (Beton mit Querarmatur, Verglichen mit "Béton Fretté"). L. A. Sanders. A description, with illustrations and table, of tests of concrete blocks reinforced transversely with many small bars. 1000 w. Beton & Eisen—2 Heft, 1903. No. 54836 F + H.

The Influence Lines of a Beam Fixed at

Both Ends and Their Application to Compound Beams (Die Einflusslinien eines an den Beiden Enden Eingeklemmten Balkens und Ihre Anwendung auf Verbundbalken). Prof. G. Ramisch. A mathematical and graphical discussion of the bending moments and stresses in beams and the application of the results to reinforced-concrete beams. Diagrams. 4000 w. Beton & Eisen—2 Heft, 1903. No. 54838 F + H.

The Shearing Stresses in Reinforced-Concrete Beams (Die Schubspannungen in Betoneisenträgern). Dr. Max v. Thullie. A mathematical and graphical discussion of the shearing stresses in reinforced-concrete beams and of the results of some tests. 2500 w. Beton & Eisen—2 Heft, 1903. No. 54837 F + H.

Reinforced-Concrete Bridges of Limited Height over Railways (Wegüberführungen in Armiertem Beton bei Beschränkter Konstructionshöhe. Hr. Mörsch. An illustrated description of two small reinforced-concrete bridges for railway crossings in Germany. 1000 w. Beton & Eisen—2 Heft, 1903. No. 54833 F + H.

Reinforced-Concrete Bridges of the Jura-Simplon Railway (Note sur les Ponts Sous Rails en Béton de Ciment Armé Construits dès 1894 par la Cié. de Chemins de Fer Jura Simplon). E. Elskes. An illustrated description of Swiss railway bridges of reinforced concrete. 1 Plate. 1000 w. Beton & Eisen—2 Heft, 1903. No. 54834 F + H.

Ferro-Concrete Warehouse at Newcastle-on-Tyne. An illustrated description of a recently built warehouse on the Hennebique system. 1400 w. Engng—April 17, 1903. No. 54954 A.

Rusting.

Comparative Tests on the Rusting of Wrought Iron and Steel (Vergleichende Untersuchungen von Schweisseisen und Flusseisen auf Widerstand gegen Rosten). An abstract of Prof. Rudeloff's report in the Mitteilungen aus den Königlichen Technischen Versuchsanstalten" of elaborate experiments to determine the relative resistance to rusting, under various conditions, and with various methods of protection, of different kinds of iron and steel. 4000 w. Stahl u Eisen—March 15, 1903. No. 43829 D.

Slag Cement.

The Manufacture of Iron-Portland Cement from Blast-Furnace Slag (Die Verwertung der Hochofenschlacke zu Eisen-Portlandzement). Hr. Jantzen. Paper before the "Verein zur Beförderung des Gewerbfleisses," giving a historical and technical account of the manufacture of hydraulic cement from blast-furnace slag. Diagram. 8500 w. Stahl u Eisen—March 15, 1903. No. 54826 D.

Steel Cleaning.

Sand-Blast Cleaning of Structural Steel. Discussion of paper by George W. Lilly. 6500 w. Pro Am Soc of Civ Engrs—April, 1903. No. 54970 E.

Steel Preservation.

Official Report on Preservation of Structural Steel in a Tall New York Building. Condensed Report of Jas. P. Whiskeman to the Superintendent of Buildings, in regard to the condition of the Pabst Building, recently demolished. Ill. 1800 w. Eng Rec—April 18, 1903. No. 54764.

Steel Specifications.

Recent Advances in the Standardization of Steel Specifications. Concerning the revised specifications adopted, comparing them with the previous standards. 3500 w. Ir Age—April 30, 1903. No. 54984.

Timber.

Notes on the Treatment of Timber. S. W. Labrot. A brief review of the various methods, and the cost. 1500 w. Ry & Engng Rev—April 18, 1903. No. 54743.

The Hardy Catalpa for Posts and Ties. Gives interesting facts in regard to the culture of these trees and their value. 2000 w. Eng Rec—April 18, 1903. No. 54771.

MEASUREMENT.

Base Line.

Base Line Measurements with Steel Tapes. Arthur D. Butterfield. Describes apparatus used, methods employed and results obtained by the writer. Ill. 3400 w. Jour Worcester Poly Inst—March, 1903. No. 54605 C.

Level.

The Gradient-Telemeter Level and Its Advantages on Preliminary Work. R. W. MacIntyre. Illustration, with description of this instrument and the principle upon which it works. 1800 w. Can Soc of Civ Engrs, Adv Proof—March, 1903. No. 54544 D.

Level Rod.

A Rod for Rapid and Accurate Leveling. Illustrates and describes the Heghmian level rod and slope tape. Cut, fill or elevations are read directly from the rod. 1800 w. Eng Rec—April 4, 1903. No. 54558.

Stadia Lines.

Stadia Lines. H. Dennis Taylor. Describes the simple or direct method of applying stadia lines to instruments, and also the anallatic method. 1300 w. Engng—April 17, 1903. No. 54956 A.

Underground Surveying.

Errors in Underground Surveying with the Fast Needle. Discusses how errors occur in the use of the vernier dial and how they may be avoided. 2400 w. Col Guard —March 27, 1903. No. 54508 A.

MUNICIPAL.

Factory Waste.

The Admission of Factory Wastes to the Sewers. Editorial discussion of English law in regard to sewage disposal. 1700 w. Engng—April 3, 1903. No. 54658 A.

Fire Apparatus.

Some Modern Appliances for Life Saving at Fires. Illustrates and describes mechanical and other devices used, and methods of rescue. 1200 w. Sci Am—April 4, 1903. No. 54489.

Havana.

Street Improvements in Havana. Charles E. McDowell. Brief description of the conditions and the proposed remedies. 800 w. Eng Rec—April 25, 1903. No. 54798.

Pavements.

Brick Pavements in Toronto. Charles W. Dill. Reports them as well adapted to this northern climate and gives the method of construction. Ill. 1300 w. Munic Jour & Engr—April, 1903. No. 54580 C.

Coal-Tar Pavements in Northern New England. Particulars in regard to a pavement laid in Hanover, N. H. Also information furnished by Prof. John V. Hazen in regard to similar pavements in other places. 1500 w. Eng Rec—April 25, 1903. No. 54793.

Kreodone Wood-Block Pavements. Frank W. Moulton. Describes the method of treating the block, and claiming remarkable wearing qualities. 1800 w. Munic Jour & Engr—April, 1903. No. 54583 C.

Refuse Destructors.

The Use of Refuse Destructors in Power Plants. States the requirements of a successful destructor; the methods of burning, types of furnace in use, and brief accounts of various works, mostly in England. Ill. 3500. Engr, U S A—April 1, 1903. No. 54574.

Sewage.

Sewage and Refuse Disposal. Describes the tanks, distributing chamber, sludge beds, etc., of the latest system of bacterial treatment of sewage in Great Britain. 3200 w. Munic Jour & Engr—April, 1903. No. 54582 C.

Sewage Pumping.

See Mechanical Engineering, Hydraulics.

Sewer Ventilation.

Ventilation of Sewers and Drains. R. Read. Read at Birmingham meeting of the English Assn of Munic. & Co. Engrs. Describes the practice in English cities, and some of the difficulties overcome. 3500 w. Munic Jour & Engr—April, 1903. No. 54581 C.

Sewers.

Concrete Sewers. Walter C. Parmley. Illustrates and describes a system of concrete and steel construction devised by the writer. 1000 w. Engng—April, 1903. No. 54599 C.

Sewer System for Indiana Harbor, Indiana. Otto Gersbach. Describes the plant of a town on Lake Michigan. 1200 w. Eng Rec—April 11, 1903. No. 54683.

Sidewalk Vaults.

The Misuse of Public Sidewalk Areas and Vaults. Reginald Pelham Bolton. Discusses some of the encroachments on the public property under sidewalks, and upon them. 1200 w. Eng Rec—April 18, 1903. No. 54767.

WATER SUPPLY.

Filtration.

The Marborough Brook Filter Beds. Walter W. Pach. Illustrates and describes the construction and operation of these filter beds, as an illustration of the application of the principles of slow sand filtration of water to a case presenting many unusual features. 3000 w. Eng News—April 16, 1903. No. 54697.

Fire Service.

The Quantity of Water Used for Fire Service in Madison. J. H. Neef. Gives a study of the Madison fires. 1500 w. Wis Engr—Feb., 1903. No. 54608 D.

London.

The Water Supply of the Metropolis. Reviews a report by Mr. Maurice Fitzmaurice on the conditions of the Thames and Lea, in relation to the water supply of the London district. 1800 w. Engng—April 10, 1903. No. 54729 A.

Organisms.

On the Practical Value of Presumptive Tests for Bacillus Coli in Water. George C. Whipple. Presented at New Orleans meeting of the Am. Pub. Health Assn. Describes method of making the tests, discussing the practical value. 4000 w. Tech Quar—March, 1903. No. 54596 E.

Vaulation.

A Water Works Appraisal at Mobile, Ala. Abstract of the report of a commission appointed to determine the value of a plant to be purchased. 7000. Eng News —April 23, 1903 No. 54915.

Waste.

Water Waste Investigations in New York City. A further report giving the results of eight districts, with particulars. 1500 w. Eng Rec—April 18, 1903. No. 54769.

Water Tower.

Water Tower, Westinghouse Works, Manchester. Illustrated detailed description of a tower constructed for the purpose of supporting two large tanks for the storage of a large volume of water under conditions of constant high pressure. 1000 w. Engr, Lond—April 10, 1903. No. 54722 A.

MISCELLANY.

Consulting Engineers.

Consulting Engineers and Their Work. Dr. Alexander B. W. Kennedy. Inaugural Address of the Session 1902-3 of the City and Guilds Central Technical College. On the duties and work of an engineer after his training is over. 5000 w. Engng—March 27, 1903. No. 54515 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

How Cables Are Laid, Worked, and Mended. J. W. Davis. A descriptive account of the work. 3300 w. Gunton's Mag—April, 1903. No. 54470.

Conduits.

Underground Conduits in Chicago. George W. Jackson. An illustrated article showing the extent and describing the construction of the underground conduits of the Illinois Telephone and Telegraph Company. 2800 w. Page's Mag—April, 1903. No. 54755 B.

Faller Telephone System.

The Faller Mechanical Telephone Operator. Frank C. Perkins. An illustrated description of an interesting invention by Ernest A. Faller. 900 w. Elec, N Y—April 1, 1903. No. 54475.

Philippines.

Telegraph Engineering in Moro Land. A short illustrated account, by a Signal Corps man, of the methods and working conditions under which military communication is maintained in field operations in the Philippines. 1400 w. Engineering Magazine—May, 1903. No. 54854 B.

Space Telegraphy.

Recent Application of the Braun-Siemens & Halske System of Wireless Telegraphy. E. Guarini. An illustrated account of German shore stations and military apparatus for the German Army, and a short discussion of the distinctive features of the Braun and the Slaby systems. 1200 w. Elec Rev, Lond—March 20, 1903. No. 54646 A.

The Development of Marconi's System of Wireless Telegraphy. Emile Guarini. An illustrated historical review of Marconi's work in this field. 1300 w. Sci Am Sup—April 25, 1903. 1st part. No. 54912.

The Lodge-Muirhead System of Wireless Telegraphy H. C. Fyfe. An illustrated detailed description of the installation in Kent, England. 1500 w. Sci Am—April 18, 1903. No 54737.

The Lodge-Muirhead Wireless Telegraph System. H. C. Marillier. An illustrated description of a system based on scientific principles. One of the valuable features is the direct application of ordinary telegraphic signalling apparatus, both at the sending and receiving ends. 2000 w. Elect'n, Lond—March 27, 1903. No. 54517 A.

"Wireless" Telegraphy. Ed. C. de Segundo. Discusses the present position of cables and "wireless" telegraphy from a commercial point of view, and the probability of long-distance cables being superseded by any wireless system. 4500 w. Page's Mag—April, 1903. No. 54756 B.

Wireless Telegraphy in the United States. E. Guarini. An account of Edison's system, presented in 1891; and of the designs of Phelps, Gilliland, and Tesla for communication between trains, are given in the present article. Ill. 1500 w. Elec Rev, Lond—April 17, 1903. Serial. 1st part. No. 54944 A.

Telegraphone.

The Telegraphone and the British Post-Office. Herbert C. Fyfe. An illustrated description of this instrument that records and reproduces the message spoken into it. 1200 w. Sci Am—April 25, 1903. No. 54911.

Telephone Exchanges.

Telephone Exchanges. Arthur V. Abbott. The present article deals with the sub-station and its apparatus. Ill. 3000 w. Elec Wld & Engr—April 25, 1903. Serial. 1st part. No. 54913.

A Central Energy Multiple Telephone System. E. T. Evans. Explains the operation of a system in use in an exchange having about 3000 subscribers. 2800 w. Am Elect'n—April, 1903. No. 54486.

Reconstruction of the National Telephone Co.'s Glasgow System. An illustrated description of the work. The method adopted is an adaptation of the "ringing through" principle to the central battery signalling system, used in connection with multiple switchboards fitted with branching jacks. 3200 w. Elect'n, Lond—April 17, 1903. No. 54947 A.

White House.

The New Telephone and Telegraph

Bureau at the White House. Waldon Fawcett. An illustrated article describing the fine equipment which is of such invaluable service to the President. 1200 w. Elec Rev, N Y—April 18, 1903. No. 54748.

DISTRIBUTION.

Circuits.

Circuits for the Transmission and Distribution of Electrical Energy. A. S. M'Allister. Describes an ingenious arrangement of interconnected circuits, and the behavior of the currents. 2500 w. Am Elect'n—April, 1903. No. 54482.

Switches.

Recent High-Voltage Switches (Neuere Hochspannungsschalter). A. Gerhardt. Illustrated descriptions of switches for electrical plants with high voltages. 2800 w. Elektrotech Zeitschr—April 9, 1903. No. 54818 B.

Wiring Rules.

The Institution of Electrical Engineers' New Wiring Rules. Gives a copy of the new set of general rules recommended for wiring for the supply of electrical energy. 6000 w. Elect'n, Lond—March 20, 1903. No. 54419 A.

ELECTRO-CHEMISTRY.

Accumulators.

A Contribution to the Theory of the Lead Accumulator (Ein Beitrag zur Theorie des Bleiakkumulators). M. U. Schoop. An illustrated description of a method of measuring the internal resistance of lead storage batteries, an account of experiments, and a discussion of the relation between the apparent and the real active surface, and other points, with diagrams. 3000 w. Elektrotech Zeitschr—March 19, 1903. No. 54810 B.

Antimony.

The Electrolytic Production of Antimony. Abstract of an article by J. Izart, in the *Industrie Electrique*. A brief account of observations upon the electro-metallurgical treatment of minerals containing antimony, describing methods. 1200 w. Elect'n, Lond—April 10, 1903. No. 54718 A.

Insulation.

Insulating Materials; A Field for the Chemist. Max von Recklinghausen. Read at the N. Y. meeting of the Am. Elec-Chem. Soc. Considers the desirable and undesirable qualities of insulating materials now used, showing where chemical research would be of value. 2000 w. Eng News—April 23, 1903. No. 54917.

Progress.

Conditions of Progress in Electro-chemistry. Joseph W. Richards. Classifies the progress made under six headings, discussing them seriatim. 5500 w. Am Elec-Chem Soc—April 18, 1903. No. 54980 D.

Recent Progress in Electro-Chemistry (Neuere Fortschritte der Elektrochemie). Prof. Alfred Coehn. An address before the "Elektrotechnischer Verein" on electro-chemistry and its practical applications, particularly in the preparation of organic products. 3000 w. Elektrotech Zeitschr—March 26, 1903 No. 54813 B.

Steel Manufacture.

The Electric Reduction of Iron Ores and the Conversion of Iron into Steel in an Electric Furnace. Louis Simpson. Concerning the quality and cost. 2200 w. Electro-Chem Ind—April, 1903. No. 54674 C.

Stray Currents.

Corrosion of Metals by Electrolysis. A. A. Knudson. Read at New York meeting of the Am. Elec-Chem. Soc. Calls attention to instances of corrosive effects from unintentional electric currents and presents considerations for their avoidance. Ill. 3200 w. Elec, N Y—April 22, 1903. Serial. 1st part. No. 54780.

See also Marine and Naval Engineering Corrosion.

ELECTRO-PHYSICS.

Condenser.

The Electrodynamic Condenser. James Swinburne. A further explanation of the principle of the "electro-magnetic condenser" referred to by the writer in his recent presidential address. 600 w. Elect'n, Lond—March 27 1903. No. 54516 A.

Electromagnetism.

The Contributions of H. F. E. Lenz to the Science of Electromagnetism. W. M. Stine. Reviews the history of the science in the present number, especially the investigations of Lenz. 5000 w. Jour Fr Inst—April, 1903 Serial. 1st part. No. 54461 D.

Electrons.

The Development of the Electron Idea. W. Kaufmann. Authorized translation of an address before the Gesellschaft Deutscher Naturforscher und Arzte. A summary of the electron theory up to date, tracing the history of the development of the electron idea. 5000 w. Elec Wld & Engr—April 18, 1903. No. 54752.

Induction Coil.

The Induction Coil. James Edmund Ives. A mathematical study of the theory of the induction coil. 2000 w. Elec Wld & Engr—March 28, 1903. No. 54447.

See also Mechanical Engineering, Automobiles.

Insulation.

Effect of High Potential Discharge on

Mica Insulation. John Härdén. Reports investigations which show that a solid insulation combined with mica in condensers, or similar appartus, would be most effective without the use of oil. 1200 w. Elec Wld & Engr—April 18, 1903. No. 54753.

Ions.

Some Effects Produced by Positive Ions. Prof. John S. Townsend. A statement of the writer's theory, with an outline of the method in which it has been experimentally verified. 1200 w. Elect'n, Lond—April 3, 1903. No. 54705 A.

Magnetism.

William Gilbert and Terrestrial Magnetism in the Time of Queen Elizabeth. Prof. Sylvanus P. Thompson. Address to the Royal Geog. Soc. An analysis of the work of Gilbert in this field, with reference to other investigators. 3300 w. Elect'n, Lond—April 10, 1903. No. 54717 A.

Radio-Activity.

Radium and Other Radio-active Substances, with a Consideration of Phosphorescent and Fluorescent Substances. The Properties and Applications of Selenium and the Treatment of Disease by the Ultra-Violet Light. William J. Hammer. 21000 w. Trans Am Inst of Elec Engrs—April 17, 1903. No. 54976 D.

The Spontaneous Disengagement of Heat by the Salts of Radium (Sur la Chaleur Dégagée Spontanément par les Sels de Radium). P. Curie and A. Laborde. An account of experiments which prove that radium salts emit heat continuously, these salts maintaining a temperature about 1.5° C. above surrounding objects. 600 w. Comptes Rendus—March 16, 1903. No. 54870 D.

On the Heat Developed Spontaneously by the Salts of Radium. P. Curie and A. Laborde. Abstract translation of paper read before the Académie des Sciences. An investigation of the heat-producing power of radium. 1500. Elect'n, Lond—April 3, 1903. No. 54704 A.

The Emanations of Radium. Sir William Crookes. Read before the Royal Soc. A report of experimental investigations. 1900 w. Elect'n, Lond—April 3, 1903. No. 54706 A.

Radiography.

A Personal Experience in Radiography, Together with the Technique of Stereoscopic Radiography. Alexander B. Johnson. Explains the important details and methods. 8500 w. Sci Am Sup—April 11, 1903. No. 54670

Wave Form.

The Cathode Tube Wave Indicator. George S. Macomber. Gives an illustrated description of a cathode ray tube outfit, indicating some of its uses. 1500 w. Sib Jour of Eng—April, 1903. No. 54629 C.

GENERATING STATIONS.

Berlin Store.

Power Plant with Mechanical Draft (Kraftwerk mit mechanischen Zug). E. Josse. An illustrated description of a steam, electric and mechanical plant in a large Berlin store, the boilers in the top story being operated with mechanical draft, and the engines and generators being placed in the basement. Serial. Two parts. 7000 w. Zeitschr d Ver Deutscher Ing—March 14, April 4, 1903. No. 54800 each D.

Design.

Points in the Design of a Power Plant. W. H. Booth. The present article discusses briefly boilers, steam engines and condensing plants, generators, and accumulators, with the general design. 2500 w. Elec Rev, Lond—April 17, 1903. No. 54946 A.

Detroit.

Power Department of Park, Davis & Co., Detroit, Mich. Illustrates and describes their steam and electric generating plant recently enlarged and improved. 3200 w. Steam Engng—April 10, 1903. No. 54630.

Double Generators.

Double Generating Sets (Ueber Doppelmaschinen, insbesondere solche in Schwungradanordnung). F. Collischon. An illustrated description of some Lahmeyer generating sets, in which two dynamos, furnishing different kinds of current, and acting as flywheels, are direct coupled to a steam engine. 1400 w. Elektrotech Zeitschr—March 26, 1903. No. 54811 B.

Earthing.

Notes on the Earthing of Dynamo-Electric Machinery. Arthur Bloemendal. Brief consideration of the question not only for low-pressure, but also for high-pressure installations. 1200 w. Elec Rev, Lond—March 27, 1903. No. 54519 A.

Electrical Energy.

The Development of Electrical Energy Supplies. Mark Ruddle. Read before the Dublin Local Sec. of the Inst. of Elec. Engrs. A discussion of matters pertaining to the economical generation and distribution of electrical energy. 3500 w. Elec Engr, Lond—March 20, 1903. No. 54415 A.

Flat-Iron Building.

Power Plant of the Flat-Iron Building, New York. An illustrated description of the fine plant installed in this rather unusual office building. 3500 w. Engr, U S A—April 15, 1903. No. 54744 C.

Gas Engines.

An Application of Gas-Engines to Isolated Plant Work. An illustrated description of the power equipment of the Keystone Bank Building, Pittsburg. 1000 w. Am Elect'n—April, 1903. No. 54481.

Gold Mines.

Central Electric Power Stations for Gold Mines. J. W. Kirkland. Read before the Mech. Engrs. Assn. of the Witwatersrand. Points out mistaken principles in operating arrangements of deep-level gold mines, advocating centralization of power to the greatest possible extent and the distribution by means of electricity. 4800 w. Mech Engr—April 4, 1903. No. 54645 A.

Multiple-vs. Independent.

Multiple versus Independent Operation of Units and Central Stations. Peter Junkersfeld. Practical difficulties encountered in the operation of central station systems are discussed. An argument for independent or sectional operation. 6000 w. Trans Am Inst of Elec Engrs—April 24, 1903. No. 54977 D.

Niagara.

Six Niagara Power Installations Under Way—A Million Horse Power to be Developed at Niagara Falls. Frank C. Perkins. An illustrated article giving information relating to the power plants in process of construction, or projected, on the American and Canadian sides of the Niagara River, and how the power is to be utilized. 5500 w. Elec Wld & Engr—April 11, 1903. No. 54689.

Norway.

A Norwegian Water Power Plant. Franz Köster. Brief illustrated description of an interesting water power electrical generating plant recently completed at Hafslund, about 56 miles southeast of Christiania. 1200 w. Elec Wld & Engr—April 4, 1903. No. 54666.

Parallel Running.

Some Hints on the Care and Paralleling of Direct-Current Dynamos. Ralph Scott. Suggestions, describing methods of testing, &c. 1800. Am Elect'n—April, 1903. No. 54485.

Residence Lighting.

Electric Generator for Lighting Residence. Brief illustrated description of an installation for the lighting of a villa, and a number of domestic purposes; also furnishing the power for an automobile. 800 w. Sci Am Sup—April 18, 1903. No. 54740.

Rheostat.

See Electrical Engineering, Measurement.

Safety Devices.

Safety Devices in Central Stations and Sub-stations. Philip Torchio. Considers generally the characteristic features tending to increase the factor of safety and the reliability of operation. 2800 w. Trans Am Inst of Elec Engrs—April 24, 1903. No. 54978 D.

San Francisco.

Power Plant for the New Government Building at San Francisco. Illustrates and describes the plant for a building which is to serve the combined purposes of a court house and post-office, furnishing light, heat and power. 3000 w. Eng Rec—April 18, 1903. No. 54770.

See also Street and Electric Railways.

Size.

Economical and Safe Limits in the Size of Central Stations. H. A. Lardner. Discusses the advantages and disadvantages of large central stations; and the probable effect of steam turbine development on the size of generating units. 4000 w. Trans Am Inst of Elec Engrs—April 24, 1903. No. 54979 D.

Small Stations.

The Economical Design and Management of Small Central Stations. Considers some of the conditions of economical and efficient design and management of small electric light undertakings. 4200 w. Elec Eng, Lond—April 17, 1903. No. 54942 A.

Victoria Falls.

See Civil Engineering, Canals, Rivers and Harbors.

Willisden, Eng.

Electrical Extensions at Willisden. A detailed description of the engines and alternators added, explaining the conditions to be met. 1700 w. Engr, Lond—April 10, 1903. Serial. 1st part. No. 54721 A.

LIGHTING.

Arc Lamps.

Notes on Mechanical Details of Enclosed Arc Lamps. J. Pratt Sligh. Read before the Newcastle Local Sec. of the Inst. of Elec. Engrs. Gives an outline basis from which comparisons can be made of the suitability of any given lamp for the particular kind of work required. 4200 w. Elec Engr, Lond—March 20, 1903. No. 54416 A.

Some Notes on the Series Running of Arc Lamps of Rectified Currents. W. Rogers. Explains the mechanical method of obtaining a rectified current, describing the apparatus. Ill. 1700 w. Elec Engr, Lond—March 20, 1903. No. 54417 A.

Hoho Method.

The Principles of a New Method of Electric Lighting. Paul Hoho. Describes a method of obtaining light and very high temperatures by immersing a small sphere of silicon dioxide and silicates in an electrolyte of bicarbonate of soda and potassium and passing an electric current. 2500 w. Elec Wld & Engr—March 28, 1903. No. 54448.

Lighthouse.

The New Electric Lighthouse on Helgoland (Das Neue Elektrische Schnellblinkfeuer auf Helgoland). O. Krell, Jr. A well illustrated description of the new Helgoland lighthouse, which has a revolving light with three beams projected from high-power electric search lights placed at angles of 120°, a duration of 0.1 second. 3000 w. Elektrotech Zeitschr—April 16, 1903. No. 54820 B.

Nernst Lamp.

The Nernst Lamp (Die Nernstlampe). Oskar Bussmann. A paper before the "Elektrotechnischer Verein," giving an illustrated account of the Nernst lamp as developed by the Allgameine Elektricitäts-Gesellschaft, with results of tests. The author is one of the chief developers of the Nernst lamp. 4000 w. Elektrotech Zeitschr—April 9, 1903. No. 54819 B.

Residence.

See Electrical Engineering, Generating Stations.

Street Lighting.

See Gas Works Engineering.

Theatre Plant.

The Electric Installation in the Prince Regent Theatre at Munich (Die Elektrischen Anlagen im Prinzregenten-Theater zu München). C. Arldt. A well illustrated description of a very complete stage and theatre electrical installation. 1600 w. Elektrotech Zeitschr—April 2, 1903. No. 54814 B.

Electric Installations in Theatres. C. Arldt. An illustration description of the installation in the Prince Regent Theatre, of Munich, as an example of recent practice. 1600 w. Trac & Trans—April, 1903. No. 54904 E.

Train Lighting.

An Axle-Light System of Train Lighting. Arthur J. Farnsworth. Gives reasons why axle-systems have theoretical possibilities of meeting the exacting requirements of the problem better than other systems, and gives an illustrated description of an axle-lighting system and its operation. 2400 w. Trans Am Inst of Elec Engrs—March, 1903. No. 54776 D.

An Electric Car Lighting System. W. L. Bliss. Illustrated description of an axle-driven electric car lighting system in which the generator is located on the truck frame, the armature being rotated by means of a single reduction gearing. 5900 w. Trans Am Inst of Elec Engrs—March, 1903. No. 54774 D.

Axle-Lighting. Elmer A. Sperry. A statement of some of the problems encountered in electric train lighting, criticizing some of the methods employed in solving these problems, and announcing a new system of axle-lighting. 2800 w. Trans Am Inst of Elec Engrs—March, 1903. No. 54775 D.

Some of the Problems of Electric Train Lighting. George D. Shepardson. A brief review of the application of electricity to train lighting, the various plans and their troubles and cost. 2200 w. Trans Am Inst of Elec Engrs—March, 1903. No. 54777 D.

Discussion of Papers on Railway Train Lighting. General discussion at New York, Pittsburg, Schenectady, St. Louis and other cities. 9300 w. Trans Am Inst of Elec Engrs—March, 1903. No. 54778 D.

Train Lighting Equipments. E. Kilburn Scott. Reviews the papers by Elmer A. Sperry and by Arthur J. Farnsworth. Ill. 1000 w. Elec Rev, Lond—April 10, 1903. No. 54715 A.

MEASUREMENT.

Battery Resistance.

On the Measurement of the Internal Resistance of a Battery. J. H. Oates. Gives two methods which reduce the error caused by the running down of the cell to a minimum, and require no apparatus beyond that found in most laboratories. 1200 w. Elect'n, Lond—April 17, 1903. No. 54948 A.

Dynamometer.

See Mechanical Engineering, Measurement.

Heavy Currents.

Accurate Measurements of Heavy Currents. P. Letheule. On the results obtained in experiments performed under the direction of Prof. Janet. 900 w. Elec Wld & Engr—April 11, 1903. No. 54691.

Iron Losses.

The Determination of the Hysteresis and Eddy-Current Losses in Iron Plates by Means of Wattmeters (Ueber die Wattmetrisabe Bestimmung der Verlustziffer für Eisenbleche). B. Soschinski. A mathematical discussion of methods of measuring these energy losses in iron. 1000 w. Elektrotech Zeitschr—April 16, 1903. No. 54821 B.

Photometry.

A Preliminary Study for a New Standard of Light. J. E. Petavel. An illustrated account of investigations carried out, discussing the requirements of a photometric standard and in what manner they may be satisfied. 3000 w. Elect'n, Lond—April 10, 1903. No. 54716 A.

See also Gas Works Engineering.

Resonance.

A Study of the Phenomenon of Resonance in Electric Circuits by the Aid of Oscillograms. M. B. Field. Describes experiments made with one of the instruments invented by Mr. Duddell, the high frequency pattern of oscillograph. Ill. 4000 w. Elec Times—March 19, 1903. Serial. 1st part. No. 54410 A.

Rheostat.

A Rheostat for Shunt-Wound Field Coils when Separately Excited (Nebenschlussregulierwiderstände für Fremderregung). Carl Kinzbrunner. An illustrated description of a regulating resistance, placed across the terminals of the source of current, with many contact points to which the magnet coils can be connected, so varying the drop of potential in the latter; this arrangement is particularly useful in getting magnetization curves. 600 w. Elektroteck Zeitschr—March 26, 1903. No. 54812 B.

Field Regulation with Separate Excitation. Carl Kinzbrunner, in the *Elektrotechnische Zeitschrift*. Gives methods of regulating within wide limits. 700 w. Elec Engr, Lond—April 17, 1903. No. 54943 A.

POWER APPLICATIONS.

Alternating Current.

An Unsuccessful Experiment. Fred W. Davis. An account of an unsuccessful alternate-current motor experiment, stating the ideas upon which the experiment was based. 1400 w. Elec Engr, Lond—April 3, 1903. No. 54648 A.

Feed Pumps.

Steam v. Electrically Driven Auxiliary Plant. C. D. Taite and R. S. Downe. Read before the Manchester (Eng.) Section of the Inst. of Elec. Engrs. A comparison, considering the reliability, economy, first cost and up-keep of feed pumps, and also condensing plants. 2500 w. Mech Engr—April 18, 1903. No. 54941 A.

Fire Engine.

A New Electrical Fire Engine. A. Frederick Collins. Describes an engine recently tested at Rouen, France, and proved satisfactory. 800 w. Sci Am—April 18, 1903. No. 54739.

Heyland Motor.

The Heyland Induction Motor (Asynchronmaschinen mit Kurzegeschlossenem Kommutator, ohne in sich Geschlossene Lamellenverbindungen). Alexander Heyland. An illustrated description of a new form of the Heyland induction motor, having a power factor of unity, in which the commutator segments are not permanently shortcircuited. 1000 w. Electrotech Zeitschr—March 19, 1903. No. 54809 B.

Induction Motor Diagrams.

Some Induction Motor Diagrams (Ueber einige Diagramme zum Asynchronen Wechselstrommotor). Hans Görges. A graphical and mathematical discussion of non-synchronous alternating current motors, with diagrams. 3000 w. Elektrotech Zeitschr—April 9, 1903 No. 54817 B.

Load Equalization.

The Equalization of Load Fluctuations in Power Transmission Plants (Ueber Ausgleich von Belastungsschwankungen in Kraftübertragungsanlagen). Gustav Meyersberg. An illustrated paper before the "Elektrotechnischer Verein" on a method of compensating load fluctuations, particularly in electric hoisting plants for mines, by means of an auxiliary dynamo with a high-speed flywheel. Also discussion. 11000 w. Elektrotech Zeitschr—April 2, 1903. No. 54816 B.

Machine Shop.

The Development and Use of the Small Electric Motor. II. The Electric Motor in the Machine Shop. Fred. M. Kimball. This second paper in Mr. Kimball's series deals with the function of electric driving in increasing shop output, lays down the general principles of motor applications to machine tools, and gives valuable figures of the power required for standard tools and operations. Largely illustrated. 4100 w. Engineering Magazine—May, 1903. No. 54852 B.

The Application of Individual Motor Drives to Old Machine Tools. R. V. Wright. A discussion of the points that bear on the problem as to whether it will pay to equip tools now in use with individual motors. 2200 w. Am Engr & R R Jour—April, 1903. Serial. 1st part. No. 54476 C.

Power Test of an Electrically-Driven Shaper. An account of an interesting test made by the Cincinnati Shaper Company. Ill. 800 w. Am Engr & R R Jour—April, 1903. No. 54478 C.

Mine Hoisting.

Electric Winding Engines. E. Kilburn Scott. The present article considers the general aspects of the problem, giving details of the methods of arranging the pulleys or drums, the different types of motors, &c. Ill. 2500 w. Ir & Coal Trds Rev—April 3, 1903. Serial. 1st part. No. 54651 A.

Some Notes on Electrically-Driven Winding Engines. An illustrated description of methods employed, with remarks on the advantages of electric driving.

2000 w. Col Guard—April 17, 1903. No. 54949 A.

Polyphase.

On the Application of Three-Phase Motors to the Electrical Driving of Workshops and Factories. A. C. Eborall. Gives an introductory general discussion, and considers questions relating to the construction and performance of three-phase motors. Illustrations and discussion. 11000 w. Jour Soc of Arts—April 3, 1903. No. 54639 A.

Steering.

Modern Electric Steering Apparatus. Frank C. Perkins. Illustrates and describes various devices. 3000 w. Elec Rev, N Y—March 28, 1903. No. 54436.

Theatre Installation.

See Electrical Engineering, Lighting.

TRANSMISSION.

Insulator Pins.

Mechanical Specifications of a Proposed Standard Insulator Pin. Ralph D. Mershon. Introduction to a discussion of a proposed standard pin covering wooden pins and, so far as it may, metal ones. 1200 w. Trans Am Inst of Elec Engrs—March 27, 1903. No. 54973 D.

Burning of Wooden Pins on High Tension Transmission Lines. C. C. Chesney. Discusses the preparation of the pins, pin troubles and their causes. Ill. 1000 w. Trans Am Inst of Elec Engrs—March 27, 1903. No. 54975 D.

Insulators.

The Testing of Insulators. F. O. Blackwell. Notes and suggestions on the testing of insulators. 1800 w. Trans Am Inst of Elec Engrs—March 27, 1903. No. 54974 D.

Long Distance.

The Electrical Conductivity of the Atmosphere and the Losses Caused Thereby in Long Distance Transmission of Power. Prof. Harris J. Ryan. Abstract of a lecture delivered before the Cornell Chapter of the Sigma Xi. Considers the principles underlying the development of long distance transmission, and discusses the loss in energy due to the breaking down of the atmosphere. Ill. 1800 w. Sib Jour of Engng—April, 1903. No. 54626 C.

Montana.

A High-Voltage Power Transmission. Discussion of the paper by M. H. Gerry, Jr., on the reconstructed plant of the Missouri River Power Co., in Montana. 3800 w. Pro Am Soc of Civ Engrs. April, 1903. No. 54969 E.

The Butte Lighting and Power Company. Illustrates and describes this electric transmission plant. 5000 w. Jour of Elec—April, 1903. No. 54961 C.

Oregon.

The White River—The Dalles Transmission. An illustrated description of the 20,000 volt transmission plant recently completed and of the Knight water wheels with which it is equipped. 3500 w. Jour of Elec—March, 1903. No. 54579 C.

Transformers.

Sheet Steel for Static Transformers. Walter S. Moody. Briefly reviews the development that has resulted in great improvement in the efficiency, safety and life of transformers, and considers the improved structure of the steel used to be the principal reason for the progress made. 1500 w. Elec Wld & Engr—April 11, 1903. No. 54690.

Transformers in Transmission Systems. Alton D. Adams. Gives examples showing the practice and discusses details. 3000 w. Elec Rev, N Y—April 11 and 18, 1903. Serial. Two parts. No. 54671.

Vancouver.

Vancouver Transmission Plant. Wyatt H. Allen. The plant is for the purpose of furnishing light and power for operating the street and interurban railways, and will ultimately have a capacity of 24,000 h. p. The hydraulic arrangements are very unusual, and there are several features of exceptional interest. Also editorial. Ill. 3000 w. Elec Wld & Engr—April 18, 1903. No. 54751.

Victoria Falls.

See Civil Engineering, Canals, Rivers and Harbors.

Wire Sag.

A Determination of the Sag and the Tension in Wires (Zur Bestimmung des Durchhanges und der Spannung in Drähten). H. von Glinski. An approximate analytical and a more exact graphical method for determining the sag and tension in line wires, with diagrams. 1200 w. Elektrotech Zeitschr—April 2, 1903. No. 54815 B.

MISCELLANY.

Agriculture.

Electroculture. Emile Guarini. An examination of the recent experiments of investigators in this field, especially those of M. Sélim Lemstroem. 2200 w. Elec Wld & Engr—April 4, 1903. No. 54667.

Prospecting.

The Daft and Williams Electrical Prospecting System. Illustrated description of prospecting trials made with this system for predetermining the position of mineral ores. 1000 w. Elec Engr, Lond—April 3, 1903. No. 54647 A.

GAS WORKS ENGINEERING

Benches.

Construction and Operation of Recuperative Benches. W. A. Baehr. Read before the Ohio Gas Lgt. Assn. Considers the principal points in the operation of such benches, and discusses the proper principles of construction. Also general discussion. 9800 w. Pro Age—April 1, 1903. No. 54472.

Calorimetry.

Calorimetry of Gaseous Fuels. W. Garnet Wernham. Read before the Jr. Inst. of Engrs. Reviews the development of the modern form of gaseous fuel calorimeter, illustrating and describing various types. 3000 w. Gas Wld—March 28, 1903. Serial. 1st part. No. 54522 A.

Combination Plant.

A Combination Dellwik Water-Gas and Peebles Oil-Gas Plant at Cleethorpes. An illustrated description of the plant, indicating the various methods of usefulness and giving a statement of results. 3800 w. Jour Gas Lgt. March 24, 1903. No. 54500 A.

Distribution.

Notes on High Pressure Distribution. W. A. Learned. Read at meeting of the New England Assn. of Gas Engrs. States the problem, and describes the system adopted. Ill. Also discussion. 7000 w. Am Gas Lgt Jour—April 6, 1903. No. 54537.

The Development of the Gas Distributing System of the Suburban Gas and Electric Company in Revere and Winthrop, Mass. A. B. Tenney. Read before the N. England Assn. of Gas Engrs. An account of the work, its cost, &c., with discussion. 4500 w. Am Gas Lgt Jour—March 30, 1903. No. 54426.

Gas Producers.

The Thermal Processes in Gas Producers (Die Thermischen Vorgänge in Gaserzeuger). Fritz Lürmann, Jr. An illustrated discussion of the reactions and processes in the manufacture of gas for power purposes. Serial. Two parts. 10,000 w. Stahl u Eisen—April 1 and 15, 1903. No. 54830 each D.

Gas Transmission.

Power Transmission by Gas. Abstract of a paper by Prof. Burstall read at meeting of the Birmingham Sec. of the Inst. of Elec. Engrs. on its possibilities. Also discussion. 5200 w. Gas Wld—April 4, 1903. No. 54641 A.

Mond Process.

The Mond Power-Gas Process. An illustrated description, with statements in regard to the advantages claimed and cost. 3000 w. Jour Gas Lgt—April 14, 1903. No. 54908 A.

Natural Gas.

Natural Gas as a Factor in the Artificial Gas Business. F. W. Stone. Read before the Ohio Gas Lgt. Assn. Considers that it has helped to introduce gas as a fuel, and will eventually prove a help to artificial gas. Discussion. 6700 w. Pro Age—April 1, 1903. No. 54473.

The Central Ohio Natural Gas Fields. J. A. Bownocker. An account of their location and areas, history and development, geology and composition. Map. 4400 w. Am Geol—April, 1903. No. 54471 D.

Petroleum Lighting.

Petroleum Incandescent Lighting. Arthur Kitson. Illustrated detailed description of a petroleum incandescent plant, and account of some of the difficulties met in perfecting the system. Describes the methods of ignition. Discussion follows. 8500 w. Jour Soc of Arts—March 27, 1903. No. 54528 A.

Photometry.

A Development in Photometry. Brief account of a new instrument which seems to overcome all obstacles in the problem of the measurement of differently colored lights. 1600 w. Gas Wld—April 18, 1903. No. 54906 A.

Plant Operation.

The Operation of a Gas Works. W. A. Baehr. Gives an outline of processes employed to-day in gas plants. 3200 w. Wis Engr—Feb., 1903. No. 54607 D.

Power.

Cheap Gas for Motive Power. J. H. Brearley. Discusses prices and competition, and refers to paper by A. B. Mountain, extracts being given. 2500 w. Gas Wld—April 11, 1903. No. 54713 A.

Power Production by Gas Producers and Engines. Robert W. A. Brewer. Read before the Civ. & Mech. Engrs. Soc. Considers the advantages of a producer, the best types, blast furnace gas and large gas engines in the present article. Ill. 4800 w. Mech Engr—April 4, 1903. Serial. 1st part. No. 54644 A.

Producer Gas and Gas Engines. An explanation of how a gas producer is con-

We supply copies of these articles. See page 475.

structed and operates, showing its economy. 3500 w. Power—April, 1903. No. 54433 C.

Gas for Industrial Purposes. James H. Walker. Read at meeting of the Wisconsin Gas Inst. Information relating to the experience of the Milwaukee Gas Light Co. in the introduction of gas for industrial uses, and the methods which were successful. Illustrates appliances. 2000 w. Am Gas Lgt Jour—March 30, 1903. No. 54427.

Retort Charging.

A Visit to M. de Brouwer at Bruges. An account of the retort-charging apparatus and its operation, with illustrations. 5700 w. Jour Gas Lgt—March 24, 1903 Serial. 1st part. No. 54499 A.

Retorts.

A Proposed New System of Building Retort-Houses. The first of a series of articles, mainly introductory, setting forth the merit and advantages of reinforced concrete construction. 2200 w. Jour Gas Lgt—April 7, 1903. Serial. 1st part. No. 54649 A.

Separator.

The Mazza Separator. Translated from *Il Gaz*. An account of a simple machine and the successful experiments made. 1000 w. Gas Wld—April 18, 1903. No. 54907 A.

Street Lighting.

A Defense of the High Prices of Street Lighting in New York, and a Reply thereto. Reviews the statement made by John M. Bowers, on behalf of the Consolidated Gas Co., and the reply by Robert Grier Monroe. 1800 w. Eng News—April 23, 1903. No. 54919.

INDUSTRIAL ECONOMY

American Workmen.

Labor Conditions in America (Amerikanische Arbeitsverhältnisse). Georg Dinglinger. An interesting discussion of factory and wage systems, the character of workmen and labor conditions in general in America, by a German who worked in American shops to study conditions there. Serial. Two parts. 7500 w. Glasers Annalen—April 1 and 15, 1903. No. 54825 each D.

Coal Strike Report.

The Award of the Anthracite Coal Strike Commission. Walter E. Weyl. A review of the work of the commission and matters related. 4500 w. Rev of Revs—April, 1903. No. 54468 C.

Report of the Coal Strike Commission. Reviews the work of the Anthracite Coal Strike Commission and its findings. 3500 w. Gunton's Mag—May. 1903. No. 54965.

Competition.

American Competition with Britain, from a Canadian Point of View. A discussion of trade conditions and the contrast between English and American methods. 4500 w. Engng—April 3, 1903. No. 54656 A.

Conciliation.

The Harmonizing of Organized Labor with Organized Capital. M. Cokely. An argument for the policy of conference, conciliation, and mutual fairness, even at the expense of the exercise of considerable self-restraint. Organization, both of capital and labor, is shown to be not only contributory but essential to the settlement of the problems. 3000 w. Engineering Magazine—May, 1903 No. 54851 B. .

Industrial Progress.

Modern Industrial Progress a Social Problem. Carroll D. Wright. Extracts from an address before the National Assn. of Mfrs., at New Orleans, La. 3700 w. Ir Age—April 30, 1903. No. 54982.

Inventors.

The Inventor and the Trust. William Stanley. Reprinted from the *Springfield Republican*. Thinks the present methods adopted by the trusts, if uncontrolled, will stifle invention and retard progress. 2300 w. Elec Wld & Engr—March 28, 1903. No. 54449.

Title to Inventions and Patents by Employees. Gives a form of agreement being used by a large engineering establishment, with editorial comment. 1400 w. Am Mach—April 2, 1903. No. 54480.

Labor.

Labor's Complaint Against Capital. Frederic Hay. A short presentation of the conditions now existing, as they appear to the employee, with the employee's view of the necessary remedies. 1300 w. Engineering Magazine—May, 1903. No. 54858 B.

Political Economy and the Labor Question. J. H. Hollander. A discussion of the wage-fund theory, and the value of the political economist in solving the labor question. 3000 w. N Am Rev—April, 1903. No. 54457 D.

Labor Unions.

The Attitude of Employers Toward

Labor Unions. Extracts from an address by John Kirby, Jr., before the Nat. Assn. of Mfrs., at New Orleans. Urges the thorough organization of employers, and the protection of the wage-earner in the right to sell his labor to whom he pleases and for the price he pleases. 3200 w. Ir Age—April 23, 1903. No. 54763.

Merger Decision.

The Merger Decision. Discusses the decision in the case of the United States against the Northern Securities Company, arguing that the Sherman act should be repealed, and that its enforcement would disorganize industry. 1200 w. Gunton's Mag—May, 1903. No. 54964.

Mine Accounting.

A Practical System of Mine Accounting. E. Jacobs. The methods of the Le Roi, B. C., Mines, with reproduction of all the forms, blanks, book rulings, and record sheets. 3000 w. Engineering Magazine—May, 1903. No. 54853 B.

Mosely Commission.

The Mosely Industrial Commission Reports. Reviews the reports made by a commission representing the principal industries of Great Britain of the tour to investigate the industrial situation in the United States. 5000 w. Ir Age—April 30, 1903. No. 54983.

Municipal Trading.

Does Municipal Trading Pay? Hon. Robert P. Porter. A discussion of the advantages and disadvantages, reviewing the history of such undertakings in various countries, and especially discussing British affairs. 5000 w. Trac & Trans—April, 1903. No. 54903 E.

Premium Plan.

Cost Reduction by the Use of the Premium Plan. C. A. Colwell. A very interesting account of five months' practical experience in a large shop, describing the policy followed, the results secured, and the formulas established for standard operations. Gives some very interesting data of cost reduction by the use of the new tool steels. Illustrated. 4000 w. Engineering Magazine—May, 1903. No. 54856 B.

A Premium System Applied to Engineering Workshops. James Rowan. Gives facts gained in an experience of five-years' working of the system. 4500 w. Inst of Mech Engrs—March 20, 1903. No. 54-505 D.

The Premium System of Remunerating Labor. John Ashford. Read before the Manchester (Eng.) Assn. of Engrs. Explains the principle of this system and the features that have developed in its working. 3400 w. Mech Engr—April 18, 1903. Serial. 1st part. No. 54940 A.

A Modification of the Premium Plan. W. H. Booth. A discussion of methods of adjusting rates, with editorial criticism. 1800 w. Am Mach—April 16, 1903. No. 54700.

Shipping Subsidies.

Shipping and Subsidies. Benjamin Taylor. A discussion of the conditions of British and American shipping, and denial of statements made in articles by Charles H. Cramp. 6200 w. N Am Rev—April, 1903. No. 54456 D.

Shop Records.

A Work in Progress Record. Horace L. Arnold. Describes two forms in use in the Cottrell works for historical records of events. 2200 w. Am Mach—April 23, 1903. No. 54782.

Simplon Tunnel.

See Civil Engineering, Construction.

Waterbury Injunction.

The Waterbury Injunction. A discussion of the injunction issued by Judge Elmer against the strikers and their sympathizers in Waterbury, Conn. 2000 w. Gunton's Mag—April, 1903. No. 54469.

MARINE AND NAVAL ENGINEERING

Armor-Clads.

Results of a Naval Inquiry as to Which is the Most Powerful Armor-Clad Afloat. Translated from the French of J. Delaporte, in *L'Illustration*. Determines the best armor-clad in each navy, then compares the types. Ill. 3500 w. Sci Am Sup—April 18, 1903. No. 54741.

Ballasting.

The Ballasting of Steamers. S. J. P. Thearle. Read before the Inst. of Nav. Archts. States some of the experiences which show the importance and necessity of ballasting, and considers methods which have been adopted. Ill. 4500 w. Engng—April 17, 1903. No. 54957 A.

Battleship Engines.

See Mechanical Engineering, Steam Engineering.

Battleship.

The Italian First-Class Battleship. Benedetto Brin. Illustrations, tabulated particulars and comparisons, with descriptive notes. 1500 w. Engr, Lond—April 17, 1903. No. 54953 A.

Boilers.

See Mechanical Engineering, Steam Engineering.

Cedric.

New White Star Line Steamship Cedric. A fully illustrated article describing in detail the interesting features of this new vessel. 1500 w. Marine Engng—April, 1903. No. 54492 C.

Compass.

Importance of a Correct Ship's Compass. Lieut. W. H. Faust. Reprinted from 1903 edition of Ship-Masters' directory. On compensating or adjusting the compass; deviations and their causes. 3000 w. Marine Rev—April 23, 1903. No. 54779.

Corrosion.

Corrosion in Metal Pipes on Board Ship. A. W. Stewart. Abstract of a paper before the Inst. of Nav. Archts. Gives details of investigations made by the writer on behalf of the Russian Volunteer Fleet, with the object of ascertaining if the dynamos on board were responsible for the very rapid deterioration taking place in some of the pipes. 2400 w. Engr, Lond—April 10, 1903. No. 54725 A.

Cruisers.

On the "Lines" of Fast Cruisers. C. C. P. Fitz Gerald. Read before the Inst. of Naval Archts. A discussion of this subject, with some comparisons. Ill. 1500 w. Engng—April 3, 1903. No. 54660 A.

The Argentine Cruiser "Moreno." Illustrated description of a vessel of the Garibaldi class recently launched. 800 w. Engng—April 10, 1903. No. 54727 A.

Engineers' Training.

The Training of Engineers in the United States. Prof. W. E. Dalby. Read before the Inst. of Naval Archts. A statement of facts obtained during a recent visit. 5000 w. Engng—April 10, 1903. No. 54731 A.

Floating Docks.

Barcelona Depositing Dock. Two-page plate and brief description of a floating dock of the single-sided type, attached by hinged booms to a floating outrigger. Describes the method of depositing. 800 w. Engng—March 27, 1903. No. 54513 A.

King's Lynn.

Screw Steamer for Towing, Salvage, and Fire Purposes. Illustrated detailed description of a substantial single-screw vessel built for the King's Lynn Conservancy Board, Eng. 2-page plate. 1000 w. Engng—April 17, 1903. No. 54955 A.

Lighthouse.

The New Beachy Head Lighthouse. T. Williams. Illustrates and describes the construction of the new Beachy Head lighthouse, on the English coast. 2500 w. Feilden's Mag—April, 1903. No. 54742 B.

See also Electrical Engineering, Lighting.

Merchant Marine.

The Future of Our Merchant Marine. Edwin Maxey. A discussion of the prospects of the United States as ship-builder and ship-owner. 2500 w. Gunton's Mag —May, 1903. No. 54966.

Minnesota.

The New American-Built Liner "Minnesota." Illustration, with description, of this mammoth freight and passenger steamship which will be used in the Pacific trade. 1000 w. Sci Am—April 18, 1903. No. 54738.

Paddle vs. Screw.

The Paddle vs. the Screw. From the Charleston, W. Va., *Daily Gazette*. An account of an interesting power test between new and old style steamers on the Kanawha river. Ill. 2000 w. Naut Gaz —April 2, 1903. No. 54487.

Petrol Motors.

See Mechanical Engineering, Special Motors.

Propellers.

The Screw as a Means of Propulsion for Shallow-Draught Vessels. A. F. Yarrow. Read before the Inst. of Nav. Archts. Describes and illustrates a set of experiments carried out to test the towing efficiency of the screw working in a tunnel. 2500 w. Engng—April 10, 1903. No. 54730 A.

Propellers and Rudders.

Efficiency of Propellers and Rudders. George H. Wilson. Discusses the changes in the location of the rudder and the altered position of the propellers proposed by some authorities, aiming to effect an improvement in the steering qualities and to increase the propulsive coefficient. 2700 w. Marine Engng—April, 1903. No. 54496 C.

Railroad Ferries.

Danish Government Railroad Ferries. William Kolvig. An illustrated article giving information in regard to these ferries which furnish a connection between the islands and mainland. 700 w. R R Gaz—April 24, 1903. No. 54922.

Resistance.

Further Notes on the Influence of Shoal-Water Upon the Speed of Ships. Alfred E. Luders. Calls attention to experiments which bear out, more or less, the conclusions to be formed from a study of Captain Rasamussen's investigations. 1500 w. Marine Engng—April, 1903. No. 54498 C.

School Ship.

The Nautical Preparatory School and the Ship Young America. Illustrates and describes a ship that will take young men and prepare them, while afloat, for business or college life, giving schooling, practical training and world-wide travel. 2800 w. Marine Engng—April, 1903. No. 54495 C.

The Young America. Illustration, with description, of a vessel to carry a floating school, which is under construction. Not a school ship in the usual acceptance of the term, but to carry students being prepared for business or for college, enabling them to see the world at the same time. 1400 w. Engr, Lond—March 20, 1903. No. 54406 A.

Submarine.

An Under-Water Automobile. Herbert C. Fyfe. An illustrated account of the new American submarine torpedo-boat "Protector," discussing its efficiency as compared with the Holland type. 3000 w. Page's Mag—April, 1903. No. 54754 B.

Warships.

Modern Warships. W. H. Whiting. Read before the Inst. of Naval Archts. On the effect of features introduced during the last twenty years, which are not necessary to the main object of a warship, on the size and cost of these vessels. 5200 w. Engng—April 3, 1903. No. 54659 A.

Yachts.

Launch of the "Reliance." Illustrations, with description of the striking features. 800 w. Sci Am—April 25, 1903. No. 54910.

MECHANICAL ENGINEERING

AUTOMOBILES.

Agriculture.

Motors in Agriculture. The first of a series of illustrated articles showing the applications made of motors. The present article deals with steam cultivation. 800 w. Sci Am Sup—April 11, 1903. Serial. 1st part. No. 54668.

Construction.

Influence of Carriage Styles on the Construction of Automobiles. Marcus C. Kramp. A discussion of types and development in automobile design, with illustrations. 4700 w. Automobile—April 11, 1903. No. 54675.

Marching Toward Simplicity in Automobile Construction. A. R. Sennett. Extracts from an address to the Roy. Auto. Clubs of Gt. Brit. and Ireland. Calling attention to the evolution which has taken place. 2500 w. Automobile—April 4, 1903. No. 54531.

Electric Vehicles.

Electric Pleasure Vehicles for All Purposes and Purses. Describes the ideal pleasure carriage, its construction and operation, giving points about the storage battery and illustrating styles of vehicles on the market and range of prices. 4000 w. Automobile—March 28, 1903. No. 54425.

Exhibition.

The Annual Agricultural Hall Exhibition. A report of this exhibition at Islington, with illustrated descriptions of exhibits. 3200 w. Auto Jour—March 28, 1903. Serial. 1st part. No. 54525 A.

India-Rubber.

India-Rubber. Mervyn O'Gorman. Some facts about this substance that motorists should know. 2000 w. Autocar—April 18, 1903. No. 54905 A.

Induction Coils.

The Induction Coil Explained. An explanation of the principles and construction. 1700 w. Autocar—March 28, 1903. Serial. 1st part. No. 54526 A.

Motor Carriers.

Motor Carriers for Small Crops. G. Lacy Hillier. The advantages of these vehicles for handling small crops and supplies are discussed. 2000 w. Autocar—April 11, 1903. No. 54711 A.

Motor Cycle.

An Expert's View of the Motor Cycle. Discusses the advantages and disadvantages, with conclusions in its favor. 2000 w. Automobile—April 11, 1903. No. 54676.

Motor-Vans.

Motor-Vans for Railway Companies. Brief illustrated descriptions of vehicles designed to replace horse-drawn vans for goods collection and delivery. 2000 w. Transport—April 3, 1903. No. 54638 A.

Omnibuses.

Steam Omnibuses at Westerly, U. S. A. Hugh Dolnar. Brief illustrated description of vehicles put in service for passenger transportation, and package delivery. 1500 w. Autocar—April 11, 1903. No. 54710 A.

Petrol Cars.

Hints on Driving Petrol Cars. General remarks on the handling of these vehicles. 1600 w. Motor Car Jour—April 18, 1903. No. 54937 A.

Petrol Cars. An illustrated review of

the petrol cars shown at the exhibition in Islington. 7500 w. Autocar—March 28, 1903. No. 54527 A.

The Chenard and Walcker 14 H. P. Petrol Car. An illustrated detailed description. 2200 w. Auto Jour—April 11, 1903. No. 54712 A.

The Dietrich-Bugatte Petrol Cars. Illustrates a partly finished 24 H. P. chassis and the engine in position. Also gives a side elevation and plan of the car. Chiefly interesting because of the peculiar construction of the engine. 700 w. Auto Jour—April 18, 1903. No. 54936 A.

The "Soames" Petrol Car. Full illustrated description of this car. 1500 w. Auto Jour—March 28, 1903. Serial. 1st part. No. 54524 A.

Steam Cars.

The Chaboche Steam Cars. An illustrated detailed description of the system and mechanism. 1800 w. Auto Jour—March 28, 1903. Serial. 1st part. No. 54523 A.

Steam Engine.

Simple Form of Steam Engine for Self-Propelled Commercial Vehicles. Walter L. Bodman. An illustrated detailed description of the Simpson D. Bodman's three-cylinder vertical engine for superheated steam. 3000 w. Automobile—April 25, 1903. No. 54781.

Trucks.

A Novelty in Steam Trucks. Illustrates and describes a propelling mechanism which is intended to be applied to ordinary horse-drawn trucks. 1800 w. Automobile—March 28, 1903. No. 54424.

HYDRAULICS.

Plumbing.

Water Supply and Distribution in the Corn Exchange Bank Building, New York. Describes the general arrangement, giving details of pumps, tanks and drains. Ill. 1200 w. Eng Rec—April 4, 1903. No. 54561.

Pumping Station.

A Sewage Pumping Station at Santiago, Cuba. Brief illustrated description of the plant. 1200 w. Eng Rec—April 25, 1903. No. 54792.

Water-Wheels.

Tangential Water-Wheels. An illustrated article describing these wheels and their development. 3500 w. Engng—March 27, 1903. No. 54509 A.

MACHINE WORKS AND FOUNDRIES.

American Turret Lathe.

New Works of the American Turret Lathe Mfg. Company. Gives an illustrated detailed description of the works, stating the considerations that were given prominence in their design. 1800 w. Ir Age—April 30, 1903. No. 54981.

Backing-Off Attachment.

Backing-Off Attachment for the Lathe. William Runge. Illustrated description of an attachment intended for relieving or backing off the teeth of formed cutters, hobs, taps, etc., and is fitted to a lathe having a taper turning attachment. 700 w. Am Mach—April 23, 1903. No. 54785.

Brass Furnace.

A Home-Made Brass Furnace. Millard F. Smith. Brief illustrated description. 600 w. Foundry—April, 1903. No. 54601.

Cams.

See Mechanical Engineering, Power and Transmission.

Castings.

Foundry Accounting and Methods of Estimating Cost of Castings. O. C. Barrows. Read at meeting of the N. Eng. Found. Assn. Describes a method that has proved satisfactory. 3500 w. Ir Trd Rev—April 16, 1903. No. 54732.

Strength of White-Iron Castings as Influenced by Heat Treatment. A. E. Outerbridge, Jr. Read at meeting of the Am. Soc. of Testing Materials, June, 1902. Gives a résumé of the history of the process of heat-treatment of white-iron castings, and states facts regarding tensile strength and other features of interest. 3800 w. Jour Fr Inst—April, 1903. No. 54460 D.

Countershafts.

Strength of Countershafts. Frank B. Kleinhans. Discusses the causes of accidents from countershafts, principally the failures due to the shaft being too long between hangers. 1000 w. Mach, N Y—April, 1903. No. 54474 C.

Dies.

Die for Piercing Brass Shells. Illustrates and describes a die for punching three holes in the side of a drawn brass shell. 1000 w. Am Mach—April 2, 1903. No. 54452.

Electric Driving.

See Electrical Engineering, Power Applications.

Feed.

Automatic Feed for Embossing Press. Illustrates and describes an automatic rack feed and its operation. 1200 w. Am Mach—April 23, 1903. No. 54783.

Foundry.

The Advantages of Having a Foundry Attached to an Existing Engineering Works in the Country. J. A. Coombs. Shows the effect in cost of castings and considers the subject generally. 1800 w. Prac Engr—April 3, 1903. No. 54642 A.

Foundry Management.

Foundry Management in the New Century. VI. The Dressing of Castings. Robert Buchanan. Reviews the methods and apparatus used in cleaning castings by tumbling, sand blast, abrasive wheels, and pneumatic tools, with the comparative merits, cost, and effectiveness of each. Illustrated. 3500 w. Engineering Magazine—May, 1903. No. 54855 B.

Rigs as a Factor in Foundry Management. Edward Kirk. An article discussing the advantage of proper rigging. 1600 w. Foundry—April, 1903. No. 54603.

General Electric.

The Plant and Operations of the General Electric Company, Ltd., at Witton. An illustrated descriptive account. 1800 w. Ir & Coal Trds Rev—April 17, 1903. No. 54958 A.

Grinding.

The Grinding Machine and Its Possibilities. H. Darbyshire. Based on experience gained in the workshops of Alfred Herbert, Limited, in Coventry, England. Discusses important points in grinding. 5500 w. Engr, Lond—March 20, 1903. No. 54407 A.

The Grinding Machine and Some Tools. H. Darbyshire. The first of a series of articles discussing the work done by grinding machines, and describing experiments made with surface grinding machines. 3500 w. Engr, Lond—March 27, 1903. Serial. 1st part. No. 54501 A.

Lathe.

A Large Turret Lathe. Drawings of the principal parts of an exceptionally large flat turret lathe, with descriptive notes. 900 w. Engr, Lond—April 3, 1903. No. 54663 A.

Lathe Apron.

Engine Lathe Apron. Illustrated description of the apron with which the lathes of the Draper Machine Tool Co. are fitted. 700 w. Am Mach—April 9, 1903. No. 54584.

Milling Machines.

Some Features of a Milling Machine Shop. An account of a shop in Milwaukee, and some of the things seen there. Ill. 1800 w. Am Mach—April 2, 1903. No. 54451.

The New Le Blond Milling Machine. Illustrated description of these machines, calling attention to some features which are of interest. 1300 w. Ir Age—April 2, 1903. No. 54450.

Patterns.

Making a Herring-Bone Pinion Pattern. G. F. Dodge. Illustrates and describes the method used. 500 w. Am Mach—April 23, 1903. No. 54784.

Pneumatic Tools.

Pneumatic Tools and Appliances. Ewart C. Amos. Abstract of a paper before the Manchester Assn. of Engrs. Considers hammers and riveters, drilling machines, screen shaker, rock drill, etc. Ill. 2500 w. Mech Engr—March 21, 1903. No. 54414 A.

Pressed Axles.

A New Method of Making Railway Axles (Eine Neu Herstellung von Eisenbahnachsen). Prof. Reuleaux. An illustrated paper before the "Verein für Eisenbahnkunde" in Camille Mercader's method of forming steel axles by punching a heated bar axially and forcing the metal into a die. With discussion. 2000 w. Glasers Annalen—April 1, 1903. No. 54824 D.

Rolling Mills.

Measuring the Power Required for Street Rolling Mills. H. G. Manning. Gives a power chart used by the writer, and explains its use. 700 w. Eng News—April 23, 1903. No. 54918.

Rolls.

Chill Rolls. R. E. V. Luty. Considers some of the problems of their manufacture and use. 4000 w. Ir Age—April 23, 1903. Serial. 1st part. No. 54761.

Tools.

Labor-Saving Tools at the Baltimore Repair Shops. Illustrates and describes some of the especially designed tools for work in these shops. 3000 w. St Ry Jour—April 4, 1903. No. 54562 D.

Welding.

Welding in Place the Broken Rudder-Post of a 9000-Ton Screw Steamer. Robert Grimshaw. Brief illustrated description of the welding in place by use of "thermit." 500 w. Am Mach—April 9, 1903. No. 54586.

See also Electrical Engineering, Miscellany.

MATERIALS OF CONSTRUCTION.

Axle Steel.

A Study of the Relations Between the Microstructure, the Heat Treatment, and the Physical Properties of Axle Steel. Henry Fay, A. W. Higgins, and F. W. Coburn. Reviews the work of other investigators, and describes tests made by the authors, discussing the results. Ill. 3000 w. Tech Quar—March, 1903. No. 54595 E.

Brass.

The Production of a Black Color on Brass. Erwin S. Sperry, in the *Metal Industry*. Describes the solution and method generally employed. 900 w. Ir Age—April 16, 1903. No. 54673.

Fracture.

The Fracture of Metals Under Repeated Alternations of Stress. J. A. Ewing and J. C. W. Humfrey. From the *Philosophical Transactions* of the Royal Soc. of London. Describes experiments in which the microscope has been applied to study the nature of the process of fatigue by which breakdown occurs under repeated reversals of stress. Ill. 3500 w. Metallographist — April, 1903. No. 54-610 F.

MEASUREMENT.

Belting Chart.

Belting and Pulley Chart. A. G. Holman. Gives the chart and rules explaining its use. 1200 w. Power—April, 1903. No. 54431 C.

Dynamometer.

Design for a 15-Horse-Power Brake Dynamometer. Nathaniel R. Craighill. Working drawings and description of a friction brake intended for use in testing electric motors, gas engines, or other machines, the capacity of which does not exceed 15 h.-p. 1800 w. Am Elect'n —April, 1903. No. 54484.

Recording Instruments.

Observing and Recording Rapidly Varying Periodical Phenomena (Sur l'Observation et l'Enregistrement de Phénomènes Périodiquement et Rapidement Variables). E. Hospitalier. An illustrated paper discussing modern methods and devices for observing and recording phenomena in engineering work, with special reference to rapid and periodical variations. 7500 w. Mem Soc Ing Civils de France—Feb., 1903. No. 54840 G.

Slide-Rule.

The Hazen-Williams Hydraulic Slide Rule. Describes the method of using this slide-rule, for computing the flow of water in pipes and channels. 2800 w. Eng Rec—March 28, 1903. No. 54446.

Test Pieces.

The Influence of Variations in the Section of Test Pieces upon the Results of Tensile Tests (Der Einfluss von Ungleichmässigkeiten im Querschnitte des Prismatischen Teiles eines Probestabes auf die Ergebnisse der Zugprüfung). Hr. Diegel. A discussion, with diagrams and tables, of the different results of different tests for elongation and tensile strength caused by turning down the central part of the test piece. 700 w. Zeitschr d Ver Deutscher Ing—March 21, 1903. No. 54-802 D.

Wire Sag.

See Electrical Engineering, Transmission.

POWER AND TRANSMISSION.

Air Compression.

Air Compression by Water Power. The Installation at the Belmont Gold Mine. D. G. Kerr. Brief illustrated description of this plant, with reasons for its choice in preference to electricity. 2400 w. Can Min Rev—March 31, 1903. No. 54533 B.

Air Compressor.

A Compound Air Compressor with Hoerbiger Valves (Verbundkompressor mit Lenkerventilen, Bauart Hoerbiger). L. Walther. An illustrated description of an air compressor fitted with linked plate valves on the Hoerbiger system, built by the Dingler Machine Works in Zweibrücken. Indicator diagrams. 1 plate. 1500 w. Zeitschr d Ver Deutscher Ing—April 4, 1903. No. 54805 D.

Belts.

The Slip of Belts. J. Stormonth. A consideration of this subject, showing how slip or creep takes place, and the benefit of pulleys. large in diameter, for belt driving. 2700 w. Engr, Lond—April 3, 1903. No. 54664 A.

Cam.

Theory of the Stamp Battery Cam. R. W. Chapman. A study of the geometry of the problem. 2000 w. Aust Min Stand—March 5, 1903. No. 54719 B.

Compressed Air.

Transmission of Power by Compressed Air. W. C. Popplewell. Considers the uses to which it can be applied, its economy, objections to its use, and related matters. 4000 w Mech Engr—April 18, 1903. No. 54939 A.

Elevators.

Vertical Transportation. A brief review of the progress made in elevator development, and the types in use. 1300 w. Sci Am—April 4 1903. No. 54488.

Fans.

Designing and Testing Centrifugal Fans. William Gilbert. The paper is supplementary, to a certain extent, to one read by Mr. Heenan in 1895, which dealt chiefly with small fans. The present paper deals with fans of larger size, giving also particulars of tests. Ill. 1400 w. Mech Engr—April 18, 1903. Serial. 1st part. No. 54938 A.

Flywheels.

Weight of Flywheels for Engines Driving Direct Connected Alternators. A. M. Levin. Derives a formula from well-established theory, supplemented by a few approximations, which conform to a number of carefully plotted displacement curves. 1500 w. Am Mach—April 23, 1903. No. 54786.

Tightening Pulley.

The Leneven Tightening Pulley for Belting (Rapport sur le Système de Commande Breveté par le Galet Enrouleur Débrayeur de M. le Capitaine Leneveu). G. Richard. An illustrated description of a balanced tightening pulley which is close to the driven pulley and increases the arc of contact of the belt up to 300 degrees. 700 w. Bull Soc d'Encouragement—March 31, 1903. No. 54845 G.

Variable-Speed Gear.

A Variable-Speed Gear for Bicycles (Rapport sur le Changement de Vitesse pour Bicyclette). M. Diligeon. An illustrated description of J. M. Roullot's change-speed gear for bicycles, in which different sized spur gears on the crank axle are made to engage with teeth on the interior of the sprocket wheel. 600 w. Bull Soc d'Encouragement—March 31, 1903. No. 54844 G.

Worm Gearing.

Test of a Triple-Thread Worm Gear Transmission (Untersuchung eines Dreigängigen Schneckengetriebes). A. Baumann. A discussion of the paper of the same title by C. Bach and E. Roser, and a graphical representation, in three dimensions, of the relations between efficiency, tooth pressure and temperature and efficiency, tooth pressure and sliding speed. 400 w. Zeitschr d Ver Deutscher Ing—April 11, 1903. No. 54808 D.

SPECIAL MOTORS.

Alcohol Motors.

Alcohol Motors at the International Competition of 1902 (Les Moteurs à Alcool au Concours International de 1902). Max Ringelmann. Data and results of tests made at the experimental station of the exhibition of 1902, at Paris, with illustrations of stationary and portable alcohol motors, and curves and tables showing their performance. 10000 w. Revue de Mécanique—March 31, 1903. No. 54-841 E + F.

Tests of Alcohol Motors and Diesel Motors (Versuche an Spiritusmotoren und am Diesel-Motor). Eugen Meyer. A long, comprehensive article, with diagrams and tables, giving an account of tests of alcohol portable engines, under the auspices of the German Agricultural Society, and of Diesel motors. Serial. Part 1. 6000 w. Zeitschr d Ver Deutscher Ing—April 11, 1903. No. 54807 D.

Banki Motor.

The Banki Motor. C. A. Dawley. Gives results of a test of a motor of this type, made by Profs. Jonas and Taborsky on an engine rated at 20 H. P. 2000 w. Sib Jour of Engng—April, 1903. No. 54628 C.

Diesel.

The Diesel Engine. Gives an illustrated description of the latest type of this engine, calling attention to its distinctive characteristics. 1600 w. Power—April, 1903. No. 54429 C.

Gas Engines.

See Electrical Engineering, Generating Stations. Also Gas Works Engineering.

Gas Turbine.

Theory of the Gas Turbine. Sanford A. Moss. Advance portion of a thesis to be presented to the Faculty of Cornell University for the degree of Ph. D. 3500 w. Engr, U S A—April 15, 1903. No. 54746 C.

Ignition.

Electric Ignition in Gas Motors. Sir David Salomons. Considers the various modes of electric ignition and the precautions which ought to be taken to prevent accidents. 3300 w. Elec Rev, Lond —March 27, 1903. Serial. 1st part. No. 54518 A.

Petrol Motors.

Marine Perol Motors at the Boating Exhibition, Earl's Court, London. Brief illustrated descriptions of some of the more important exhibits. 3000 w. Engrs' Gaz—April, 1903. No. 54634 A.

STEAM ENGINEERING.

Adiabatic Expansion.

Curves Representing Adiabatic Expansion of Steam. F. Foster. Uses the entropy diagram to determine the value for various initial conditions of pressure and dryness. 1200 w. Engr, Lond—April 10, 1903. No. 54720 A.

Battleship Engines.

Triple-Expansion Twin-Screw Propelling Engines of the U. S. Battleships Connecticut and Louisiana. Illustrated description of the engines which will be right and left hand, placed in water-tight compartments, separated by a middle-line bulkhead. 1200 w. Marine Engng—April, 1903. No. 54497 C.

Berlin Store.

See Electrical Engineering, Generating Stations.

Boiler Economy.

The Boiler Furnace and Its Relation to the Fuel. Robert S. Hale. Considers the furnace and the grate in the present article, showing how some of the methods for improving them may result injuriously to the economy of the boiler. States the principles involved in attaining good economy and discusses their application as the grades of coal used in the boiler furnace differ. 5400 w. Engr, U S A—April 1, 1903. No. 54571 C.

Boilers.

Some Miscellaneous Types of Marine Boilers. William H. Fowler. The present article illustrates and describes the multitubular boiler with oval shell. 800 w. Mech Engr—March 28, 1903. Serial. 1st part. No. 54530 A.

Combustion.

Chemistry of Combustion. John C. Olsen. Describes the changes during the burning of different fuels and the causes of the variation in calorific power. 2000 w. Engr, U S A—April 1, 1903. No. 54565 C.

Burning of Fuel Under Pressure. Charles E. Lucke. Considers the means of obtaining good combustion. 1200 w. Engr, U S A—April 1, 1903. No. 54577 C.

Compression.

Compression in Steam-Engine Cylinders. C. L. Browne. An examination of the experiments showing losses with high compression, comparing these with the better results obtained in actual practice with modern large engines. 3500 w. Elec Engr, Lond—March 27, 1903. No. 54-521 A.

Condensers.

Condensers and Cooling Towers. Charles L. Hubbard. The first of a series of articles showing the gain in power and economy by condensing operation. 2800 w. Steam Engng—April 10, 1903. Serial. 1st part. No. 54631.

The Ljungström Condenser as Applied to Marine Engines. William Cross. Abstract of a paper read before the Inst. of Naval Archts. Brief illustrated description. 800 w. Engr, Lond—April 3, 1903. No. 54665 A.

Fuels.

Bagasse as a Fuel and the Furnaces Used to Burn It. Samuel Vickers. Explains the term, and gives brief illustrated descriptions of furnaces for burning it, and information regarding its calorific value. 3200 w. Engr, U S A—April 1, 1903. No. 54576 C.

Coke as a Fuel. George L. Fowler. Considers it only in its application to steam making, and regards it as an almost ideal fuel for locomotive or stationary work, its use being merely a matter of price and supply. 1700 w. Engr, U S A—April 1, 1903. No. 54572 C.

The Determination of the Heating Value of Fuel. Herman Poole. Gives brief accounts of some of the leading methods used to determine the heating value of fuels. 2800 w. Engr, U S A—April 1, 1903. No. 54566 C.

The Value of Tar as Fuel. Charles F. Prichard. Gives facts relating to methods of burning, calorific power, and value. 1500 w. Engr, U S A—April 1, 1903. No. 54573 C.

Furnace Crowns.

Gradual Collapses of Furnace Crowns. A Suggested Explanation. H. M. Roundthwaite. Read before the Inst. of Naval Archts. Describes the stresses and their tendency. 1500 w. Mech Engr—April 11, 1903. No. 54714 A.

Governors.

Hints on the Design and Construction of Shaft Governors. C. B. Risley. Discusses points affecting regulation and durability. Ill. 1200 w. Power—April, 1903. No. 54432 C.

Liquid Fuel.

Liquid Fuel or Power Purposes. Arthur L. Williston. A valuable synopsis of the mechanical aspects of the question, based on the successful experience of some very large users of fuel oil. Gives diagrams of burners and furnaces for stationary and locomotive practice. Illustrated. 4000 w. Engineering Magazine—May, 1903. No. 54857 B.

Crude Oil as Fuel. A. M. Hunt. Condensed paper, read before the California Miners' Assn. Concerning oil-burning plants, burners, cost, etc. 2800 w. Min & Sci Pr—April 11, 1903. No. 54735.

Fuel-Oil and Oil Burners for Steam Boilers. William Kent. Gives some of the advantages of oil as a fuel, and an experimental study of its heating value, and the right way to burn it. Illustrates numerous types of burners. 2700 w. Engr, U S A—April 1, 1903. No. 54567 C.

Oil Burning at Pratt Institute. Joseph Foster. An illustrated description of the method used, reporting that to reach an economy equal to coal, oil would have to be bought for 2 cts. a gallon. 1800 w. Engr, U S A—April 1, 1903. No. 54578 C.

See also Railway Engineering, Motive Power and Equipment.

Lubrication.

The Theory of Lubrication Reduced to Practice. J. K. Nye. On the importance of understanding the correct lubricating qualities for the purpose intended. 2000 w. Marine Engng—April, 1903. No. 54-493 C.

Marine Engine.

A Marine Engine with Corliss Valve Mechanism. William H. Crawford, Jr. An account of the compound engine placed in the Steamer City of Puebla, now running in the service of the Pacific Coast Steamship Co. Ill. 1200 w. Marine Engng—April, 1903. No. 54494 C.

Mechanical Draft.

See Electrical Engineering, Generating Stations.

Mechanical Stokers.

Mechanical Stokers Depending Upon the Coking Method of Firing. Albert A. Cary. A discussion before the New England Cotton Mfrs. Assn. Gives an illustrated description of the coking method of firing, considering its advantages and disadvantages, and discussing forms of mechanical stokers. 6000 w. Engr, U S A—April 1, 1903. No. 54570 C.

Piping.

Pipe Work for Electric Lighting Stations. Suggestions for the arrangement of steam-pipe work of small or medium sized stations, recommending the header system. Ill. 2500 w. Elec Engr, Lond—March 27, 1903. No. 54520 A.

Smoke Prevention.

The Prevention of Smoke from Bituminous Coal. Charles H. Benjamin. A discussion of ways of securing the conditions necessary for perfect combustion, the devices tried and the results attained, favoring mechanical stokers. 3000 w. Engr, U S A—April 1, 1903. No. 54575 C.

Steam Turbines.

High Superheating with Steam Turbines (Die Anwendung Hoher Ueberhitzung beim Betrieb von Dampfturbinen). Ernst Lewicki. A very complete illustrated record, with diagrams and tables, of tests made at the Dresden technical high school on a de Laval steam turbine, using highly superheated steam. Serial. Three parts. 13000 w. Zeitschr d Ver Deutscher Ing—March 28, April 4 and 11, 1903. No. 54803 each D.

The Curtis Steam Turbine. W. L. R. Emmet. An illustrated paper, read before the American Philosophical Society, giving description of a development based upon the original theories and inventions of C. G. Curtis. Claims important advantages over other types. 2500 w. St Ry Jour—April 11, 1903. No. 54678 D.

A New Steam Turbine. Brief illustrated description of the Curtis steam turbine. 800 w. Elec Rev, N Y—April 11, 1903. No. 54672.

Modern Development of the Steam Turbine. Frank C. Perkins. General remarks with brief accounts of the Rateau, Curtis, Parsons and other types. Ill. 2900 w. Sci Am—April 25, 1903. No. 54909.

The Rateau Turbine. An illustrated description of this type which is extensively used abroad. 1800 w. St Ry Jour—April 18, 1903. No. 54750 D.

Superheating.

A Remarkable English Engine. Illustrated article, reporting a remarkable performance of a steam engine of moderate size, built by Easton & Co. for the British Xylonite Co. and using the Schmidt system of superheating. 1200 w. Am Elect'n—April, 1903. No. 54483.

Valve Gears.

Layout of Corliss Valve Gears. Sanford A. Moss. Gives a method for laying out a Corliss or other similar valve gear, using as a starting point the desired percentages of compression and release. Ill. 5800 w. Am Mach—April 9, 1903. Serial. 1st part. No. 54585.

The Elsner Valve Gear (Die Elsner-Ventilsteuerung). Georg W. Koehler. An illustrated description of a valve gear for steam engines, in which the amount of steam admitted is automatically regulated, illustrations of engines, and valve diagrams and their discussion. Serial. Part I. 1000 w. Glasers Annalen—March 15, 1903. No. 54822 D.

Wire-Drawing.

Notes Relating to the De Laval Steam Turbine, the Wire-Drawing Calorimeter, and the Superheating of Steam by Wire-Drawing. Prof. W. H. Watkinson. Read before the Inst. of Engrs. and Shipbuilders in Scotland. Discusses problems relating to the wire-drawing of steam. Ill. 1200 w. Prac Engr—March 27, 1903. Serial. 1st part. No. 54529 A.

MISCELLANY.

Bicycles.

Bicycles for Touring (Les Bicyclettes. Le Concours de Bicyclettes de Tourisme). Carlo Bourlet. An illustrated account of a road competition for bicycles in France and descriptions of brakes and other details. 2500 w. Génie Civil—March 14, 1903. No. 54860 D.

Drawings.

Numbering and Filing Drawings. S. A. Worcester. An outline of a system recommended, with a brief comparison with other methods. 1800 w. Am Mach—April 16, 1903. No. 54701.

Enameling Machine.

The Dupont Process of Enameling Large Hot Castings (Rapports sur l'Emaillage à Chaud des Pièces de Fonte de Grandes Dimensions d'après le Procédé de M. P. Dupont). Ach. Livache and P. Dupont. An illustrated description of a machine and process for enameling large objects, such as bath tubs, by spraying the enamel on in a closed chamber. 3000 w. Bull Soc d'Encouragement—March 31, 1903. No. 54843 G.

Engineers.

The Mechanical Engineer, His Duties, Responsibilities, and Opportunities. William H. Bryan. Address before the Washington Univ. Assn., St. Louis, Mo. 4500 w. Engr, U S A—April 15, 1903. No. 54745 C.

Heating and Ventilation.

Ventilating and Heating in the Palace of the Crown Prince of Japan. Light, heat and power is supplied by a boiler and engine plant in a separate building. Exhaust steam is employed for heating; the fresh air supply is furnished by six fans. All the apparatus is of American make. 2200 w. Eng Rec—April 4, 1903. No. 54560.

Ventilation and Heating of Rockefeller Hall, Vassar College. Describes the system adopted in this two-story and basement building, which covers a ground area of 11,540 sq. ft. 2000 w. Eng Rec—April 25, 1903. No. 54900.

Heating and Ventilating of Railroad Shops. J. I. Lyle. Considers the systems adapted to the use of exhaust steam, favoring the fan system. General discussion. 9500 w. N Y R R Club—March 20, 1903. No. 54707.

Kites.

The New Observation Kites Invented by S. F. Cody. An illustrated description of the apparatus which has proved practical and successful for general observation and meteorological experiments. 1100 w. Sci Am Sup—April 11, 1903. No. 54669.

Mechanics.

The Definition of Mechanical Phenomena (Définition des Phénomènes. Application de la Mécanique des Systèmes Matériels). A. Gouilly. A discussion of natural phenomena and the fundamental conceptions and "laws" of mechanics. Diagrams. 9000 w. Mem Soc Ing Civils de France—Feb., 1903. No. 54839 G.

Refrigerating Machine.

Tests of an Ammonia Refrigerating Machine (Versuche an einer Ammoniak-Kompressionskältemaschine). Rich Stetefeld. An illustrated description of a test of an ammonia-compression refrigerating machine built by the Halle Machine Works. 1200 w. Zeitschr d Ver Deutscher Ing—April 4, 1903. No. 54806 D.

Refrigeration.

Carbonic Anhydride Refrigerating Machinery for Marine Use. S. H. Bunnell. States the advantages of carbonic anhydride as a refrigerant, and describes machinery recently installed on new vessels. Ill. 3500 w. Eng News—April 9, 1903. No. 54588.

Shutting Down Ice Plants and Preparing Them for the Summer Season. William Nottberg. Reviews things of importance to have plants in proper order. 1800 w. Power—April, 1903. No. 54430 C.

Sand-Blast Cleaning.

See Civil Engineering, Materials.

MINING AND METALLURGY

COAL AND COKE.

Briquettes.

Briquet Fuel. W. H. Booth. Information relating to the making and use of briquets in various countries. 3000 w. Engr, U S A—April 1, 1903. No. 54564 C.

Coke Ovens.

Progress in the Heating of Horizontal Coke Ovens in the Last Twenty Years (Fortschritte in der Beheizung der Liegenden Koksöfen in den Letzten Zwanzig Jahren). An account of the construction of coke ovens and the methods of firing, heating and conducting the air and gases. 3000 w. Stahl u Eisen—March 15, 1903. No. 54828 D.

A Modern Coke Oven. Illustrates and describes the by-product ovens, ordinary and patent ovens of the Fabry-Linard System, stating the advantages claimed. 2000 w. Ir & Coal Trds Rev—March 20, 1903. No. 54409 A.

Coking.

Coking Badly Caking Coal. Illustrates apparatus and describes a new mechanical process for coking such coal. 800 w. Ir & Coal Trds Rev—April 3, 1903. No. 54654 A.

Firedamp.

Outbursts of Firedamp in Mines. A review of experimental investigations and a statement of theories advanced to explain these accumulations of firedamp and guard against the terrible consequences attending outbursts. 3000 w. Col Guard—April 3, 1903. No. 54650 A.

Germany.

Lignite, Peat and Coal-Dust Fuel in Germany. A supplementary report relating more especially to the utilization of these deposits. 3300 w. U S Cons Repts, No. 1615—April 8, 1903. No. 54542 D.

Heating Values.

Coals, Their Sources and Heating Values. John W. Langley. Concerning the origin, distribution in the United States, analyses of coals and cokes, and heating power. 1800 w. Engr, U S A—April 1, 1903. No. 54568 C.

Illinois.

Coal Mines and Zinc Works at La Salle, Illinois. A. Dinsmore. A description of mining plant at La Salle shaft, and of the Matthiessen & Hegeler zinc works. 2800 w. Mines & Min—April, 1903. No. 54441 C.

Northwestern States.

Coal Fields of the Northwestern States. Arthur L. Westcott. An account of the deposits in the portion of the United States known as the Rocky Mt. States. The character varies from lignite beds in North Dakota, to the anthracite of Colorado. 3000 w. Engr, U S A—April 1, 1903. No. 54569 C.

Tonkin.

The Coal Mines of Tonkin (Les Charbonnages du Tonkin). F. Schiff. A well illustrated description of some of the coal mines of French Indo-China and their exploitation. 3000 w. Génie Civil—March 14, 1903. No. 54859 D.

Valuation.

The Valuation of Coals. E. L. Rhead. Read before the Manchester (Eng.) Soc. of Chem. Ind. Brief discussion of methods of determining the specific gravity, moisture, ash, coking power, volatile matter, sulphur, calorific power, etc. 4000 w. Ir & Coal Trds Rev—April 3, 1903. No. 54653 A.

COPPER.

Matting.

Some Personal Experience on Matting of Ores at Leadville and Robinson, Colo. Gives results obtained, with the view of counteracting some ideas prevalent concerning capacity of furnace. 1700 w. Eng & Min Jour—April 11, 1903. No. 54693.

Smelting.

Late Improvements in Copper Smelting. Herbert Lang. From Trans. California Miners' Assn. On the changes and improvements of recent years; the pyritic process and what it has effected; other processes, and cost. 2800 w. Min & Sci Pr—April 11, 1903. No. 54736.

New Copper Smelting Plant at Rio Tinto. Illustrations of the blast furnaces and converters, with brief description of plant. 1100 w. Ir & Coal Trds Rev—Mar 20, 1903. No. 54408 A.

The Elimination of Arsenic, Antimony, Lead and Zinc from Copper Mattes. S. E. Bretherton. A brief description of the smelting practice at the Val Verde Copper Co.'s works, showing that it is not necessary to do any preliminary roasting as the objectionable elements are sufficiently eliminated in blast furnace smelting. 1800 w. Min & Sci Pr—April 4, 1903. No. 54632.

Treatment.

The Payne-Gillies Process for the Treatment of Copper Ores. James Taylor. Describes a process designed to deal with cupriferous ores, concentrates and tailings in cases where smelting would be inadmissible. 1500 w. N Z Mines Rec—Feb. 16, 1903. No. 54413 B.

GOLD AND SILVER.

Alloys.

On Certain Properties of the Alloys of the Gold-Silver Series. Sir W. C. Roberts-Austen and T. K. Rose. Read before the Royal Soc. Gives results of experiments made to obtain homogeneous trial plates by which the standard of the coinage may be tested. 800 w. Metallographist—April, 1903. No. 54612 F.

Australia.

The Minerals of West Australia. Information of value, taken from a bulletin recently issued by the Departmental Laboratory of the Western Australia Geological Survey. Gold is by far the most important mineral. 2500 w. Engr, Lond—March 27, 1903. No. 54504 A.

Colorado.

The Silver Lake Mine, near Silverton, San Juan County, Colo. Prof. Arthur Lakes. An instance of successful operation of a large mine at high altitude is described. Ill. 2200 w. Mines & Min—April, 1903. No. 54440 C.

The Camp Bird Mine, Ouray, Colorado, and the Mining and Milling of the Ore. Chester Wells Purington, Thomas H. Woods, and Godfrey D. Doveton. Gives a description of this property, its history, geology and working; also a description of the mill, the method and cost of treating the ore. Ill. 16000 w. Trans Am Inst of Min Engrs—Feb. and May, 1902. No. 54613 D.

Cripple Creek.

The Lodes of Cripple Creek. J. A. Rickard. An illustrated article explaining the occurrence of the ores and the geology of the district. 9500 w. Trans Am Inst of Min Engrs—Oct., 1903. No. 54614 D.

Dredging.

Gold-Dredging in New Zealand. C. Edward Turner, in the *Mining Journal*, London. An account of its inception, progress and practice. 6000 w. N Z Mines Rec—Feb. 16, 1903. No. 54412 B.

The Stewart River Gold Dredge. A. W. Robinson. A brief description, with illustrations. 2800 w. Can Min Rev—March 31, 1903. No. 54534 B.

Hydraulic Mining.

Hydraulicking Low-Grade Gravel. P. Bouery. Gives results obtained in working placers, showing that low grades can be worked with some profit. 1400 w. Min & Sci Pr—April 18, 1903. No. 54926.

Klondike.

Mining Methods on the Klondike. Eugene Haanel. An explanation of the methods, machinery and appliances used. Ill. 3900 w. Eng & Min Jour—April 11, 1902. No. 54694.

Mongolia.

Silver-Mining and Smelting in Mongolia. Benjamin Smith Lyman. A discussion of Mr. Y. T. Woo's paper. 1200 w. Trans Am Inst of Min Engrs—Feb. and May, 1902. No. 54618 C.

New Zealand.

Mining in the Hauraki Gold Fields. From the *New Zealand Herald*. A review of the past year's operations. 4500 w. N Z Mines Rec—Feb. 16, 1903. No. 54411 B.

Slimes.

Treatment of Slime in Tanks with Conical Bottoms. Illustration of plant with description of its operation. 1100 w. Eng & Min Jour—March 28, 1903. No. 54437.

South Africa.

Mining Methods at Johannesburg. T. Lane Carter. Notes on methods of handling ore in the deep-level mines, methods of managing the workmen, the working of the contract system and related matters. 1800 w. Eng & Min Jour—April 18, 1903. No. 54760.

Observations on the Rand Conglomerate. L. De Launay. Discusses their origin and occurrence, giving theories explanatory of the formation. 4500 w. Eng & Min Jour—April 4, 1903. No. 54539.

South Dakota.

Cambrian Ore Deposits in the Black Hills. Describes these deposits which carry a greater value in gold than in silver, and carry but little lead. 1500 w. Min & Sci Pr—April 4, 1903. No. 54633.

Veins.

The Veins of Boulder and Kalgoorlie. T. A. Rickard. An illustrated description of the veins of Boulder Co., Colorado, and the lodes of Kalgoorlie, West Australia, showing their geological unlikeness. 2000 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 54617 C.

IRON AND STEEL.

American Practice.

The Steel Works Practice of the United States. Enoch James. Read before the Conference of the Brit. Ir. Trd. Assn. Calls attention to points where American practice may with advantage and profit be imitated by English manufacturers. 3500 w. Ir & Coal Trds Rev—April 3, 1903. No. 54655 A.

Blast Furnaces.

Flue-Dirt and Top-Pressure in Iron Blast Furnaces: A Study of the Influences Controlling Them. F. Louis Grammer. A study of flue dirt and influences controlling it, based on observations of about thirty furnaces. 4000 w. Trans Am Inst of Min Engrs—Feb., 1903. No. 54616 D.

The Modern Blast Furnace Laboratory and Its Work. W. Dixon Craig. A non-technical paper considering the work of the laboratory, and the laboratory itself, with notes on some of the methods of chemical analysis used. 1600 w. Can Min Rev—March 31, 1903. No. 54532 B.

Blooming Mill.

Blooming Mill of the Röchling Iron and Steel Works. Translated from *Stahl und Eisen*. Illustrated description. 1200 w. Engng—April 10, 1903. No. 54728 A.

Cette, France.

Blast Furnace and Iron Work at Cette. Translated from *Le Genie Civil*. Illustrated description of these works, especially the blast furnace construction. 2200 w. Engr, Lond—March 27, 1903. No. 54503 A.

Continuous Mill.

The Modern Continuous Rolling Mill. Axel Sahlin. Read before the Staffordshire Ir. & Steel Inst. An illustrated article describing mills investigated during a tour of study and inspection in the United States. 9600 w. Ir & Coal Trds Rev—March 27, 1903. No. 54506 A.

Electric Reduction.

See Electrical Engineering, Electro-Chemistry.

High-Speed Steels.

The Structure of High-Speed Steels. E. L. Rhead. Suggests a possible explanation of the behavior of rapid cutting steels. 800 w. Engr, Lond—April 3, 1903. No. 54662 A.

Hot Blast.

Process for Equalizing the Temperature of Hot Gases (Verfahren zum Ausgleichen der Temperatur heisser Gase). Walter Daelen. A brief, illustrated account of the Giers and Harrison method of equalizing the temperature of the hot gases in blast-furnace work, and temperature records of the hot blast taken by the Uehling-Steinbart pyrometer. 600 w. Stahl u Eisen. April 1, 1903. No. 54832 D.

Ingot Molds.

The Durability of Ingot Molds (Haltbarkeit van Kokillen). P. Reusch. An illustrated discussion of the causes which affect the durability of ingot molds for steel works, such as their material and its treatment, their shape and thickness, and their handling. 2000 w. Stahl u Eisen—March 15, 1903. No. 54827 D.

The Durability of Ingot-Molds. P. Reusch. Abstract translation of a recent article in *Stahl und Eisen* on the proper design and handling. Ill. 1200 w. Ir Age—April 23, 1903. No. 54762.

Metallography.

On the Industrial Importance of Metallography. Albert Sauveur. Abstract of a paper, considering only iron and steel, and showing the commercial application of metallography. Discussion. 3000 w. Jour Fr Inst—April, 1903. No. 54459 D.

Meteoric Iron.

Meteoric Iron from N'Goureyma, near Djenne, Province of Macina, Soudan. E. Cohen. Description with analysis and illustrations. 2200 w. Am Jour of Sci—April, 1903. No. 54465 D.

Puddled Iron.

Puddled Iron and Mechanical Means for the Production of Same. James P. Roe. Also discussion by Joseph Hartshorne. An explanation, with illustrations, of the process developed by the writer. 3500 w. Trans Am Inst of Min Engrs—Feb. and May, 1902. No. 54624.

Siemens-Martin Process.

The Dissociation of Carbonic Oxide in the Regenerator of Siemans-Martin Furnaces (Zersetzung des Kohlenoxydgases in Wärmespeicher des Martinofens). Franz Würtenberger. Analyses of gases made at the steel works of the Soc. Lig. Metallurgica, Italy, by Dr. Mambrini, and discussion of the results and their causes. 1200 w. Stahl u Eisen—April 1, 1903. No. 54831 D.

Slag Cement.

See Civil Engineering, Materials.

Spain.

The Iron Ore Mines of Biscay. Bennett H. Brough. An illustrated article describing the country, people, mines, &c., methods employed, transportation and output. 2700 w. Cassier's Mag—April, 1903. No. 54463 B.

Steel.

The Constitution and Thermal Treatment of Steel. H. M. Howe. Reprinted from an article in the *Encyclopedia Britannica*. Considers the microscopic entities which constitutes the different varieties of iron and their effect when subjected to thermal treatment. 3500 w. Metallographist—April, 1903. No. 54609 F.

Steel Rails.

The Rolling and Structure of Steel Rails. P. H. Dudley. A report upon recent practice, giving a study of structure and tests. Ill. 4000 w. Metallographist—April, 1903. No. 54611 F.

MINING.

Deep Mining.

Underground Temperatures in Relation to Deep Mining. F. G. Meachem. Abstract of paper read before the S. Staffordshire & E. Worcestershire Inst. of Min. Engrs. A study of the earth's temperature and its variations. Also discussion. 3300 w. Col Guard—April 17, 1903. No. 54950 A.

Electric Hoisting.

See Electrical Engineering, Power Applications.

Geology.

The Geologist in Matters of Practical Mining. J. E. Spurr. A discussion of the value of this science in mining, and its practical application. 1800 w. Eng & Min Jour—April 11, 1903. No. 54692.

Hoisting.

Hoisting from Great Depths. Hans C. Behr. Abstract from the Johannesburg *Star*. An abstract of Mr. Behr's reply to the discussion of his paper read before the South African Assn. of Engrs. 2800 w. Eng & Min Jour—April 25, 1903. Serial. 1st part. No. 54927.

Hoisting from Great Depths. Robert Peele. A discussion of conclusions reached by H. C. Behr in his paper on "Winding Plants for Great Depths," giving also the writer's views. 4800 w. Eng & Min Jour—April 4, 1903. No. 54538.

Mapping.

Graphic Method of Mapping Exposed Ore Bodies. G. W. Miller. Describes a method that has been tested and used extensively with satisfaction, and been found especially adapted for ore deposits lying in continuous sheets, or those of the fissure vein, or bedded types. Ill. 2800 w. Min & Sci Pr—March 28, 1903. No. 54536.

Miners' Phthisis.

Miner's Phthisis. William Cullen. Discusses the cause and remedy for this disease so prevalent among miners. 5000 w. Jour Chem & Met Soc of S Africa—Feb., 1903. No. 54640 E.

Mine Ventilation.

Improvised Ventilating Machinery. C. M. Myrick. Describes simple appliances for inducing air currents. 1200 w. Min & Sci Pr—April 11, 1903. No. 54734.

Mining Machinery.

Notes on Accidents Due to Combustion within Air Compressors. Albert R. Ledoux. Describes a casualty due to lack of judgment and care in the use of air compressors. 1000 w. Trans Am Inst of Min Engrs—Feb., 1903. No. 54620.

Ore Deposits.

Ore Deposits at Butte, Montana. Walter Harvey Weed. Abstract from Bul. of the U. S. Geol. Survey. An outline of the main features. Ill. 3000 w. Eng & Min Jour—April 18, 1903. No. 54759.

Pumping.

The Cost of Pumping at the Short Mountain Colliery of the Lykens Valley Coal Company. R. V. Norris. Describes the conditions prevailing at these mines, the pumping plant, and the cost of pumping. Ill. 1400. Trans Am Inst of Min Engrs—Feb., 1903. No. 54622.

Shaft Linings.

Shaft Linings. An account of the different types of lining which have been employed. Ill. 3700 w. Col Guard—March 27, 1903. No. 54507 A.

Valuation.

Mining Engineering in the Valuation of Mines. G. W. Miller. A brief discussion of educational qualifications of mining engineers and their duties. 1500 w. Min & Sci Pr—April 11, 1903. No. 54733.

Water Hoisting.

Water-Hoisting in the Pennsylvania Anthracite Region. R. V. Norris. Describes the present method of hoisting, giving particulars of the water hoists in use and under construction and related information. Ill. 3800 w. Trans Am Inst of Min Engrs—Feb., 1903. No. 54615 D.

MISCELLANY.

Aluminum.

The Present Position of the Aluminum Industry. John B. C. Kershaw. The present article reviews the production and price. 1600 w. Elec Rev, Lond—March 20, 1903. Serial. 1st part. No. 54418 A.

Azores.

Geological Features of the Azores. O. H. Howarth. Gives interesting illustrations of peculiar volcanic effects both past and present. 5500 w. Mines & Min—April, 1903. No. 54439 C.

Death Valley.

Death Valley. Don Maguire. Describes this most desolate spot in North America, its history, inhabitants, and products. 4000 w. Mines & Min—April, 1903. No. 54443 C.

Furnace Bottoms.

Truck Support for Furnace-Bottoms. Henry A. Mather. Illustrates and describes this device, stating its advantages. 600 w. Trans Am Inst of Min Engrs—Feb. and May, 1902. No. 54619.

German East Africa.

Mining Regulations of German East Africa. Translation of the mining regulations and rules, with general information. 3300 w. U S Cons Repts, No. 1607—March 30, 1903. No. 54403 D.

Great Salt Lake.

The Mineral Crest, or the Hydrostatic Level Attained by the Ore-Depositing Solutions, in Certain Mining Districts of the Great Salt Lake Basin. Discussion of Dr. W. P. Jenney's paper, by George Otis Smith and S. F. Emmons. 1100 w. Trans Am Inst of Min Engrs—Feb. and May, 1902. No. 54623.

Mica.

Mica—Its Uses and Value. Charles C. Schnatterbeck. Information in regard to deposits and their quality, method of mining, uses, &c. 900 w. Eng & Min Jour—March 28, 1903. No. 54438.

Mine Accounting.

See Industrial Economy.

Nickel.

Progress in the Metallurgy of Nickel During 1902. Titus Ulke. Reviews the development in various districts and the processes used. 2800 w. Eng & Min Jour—April 25, 1903. No. 54929.

Development in the Nickel Industry at Sault Ste. Marie, Ontario, Canada. E. A. Sjostedt. Gives results obtained at Sault Ste. Marie in the roasting of mono-sulphides without the aid of auxiliary heat. 1200 w. Eng & Min Jour—April 25, 1903. No. 54930.

Ore-Deposition.

The Chemistry of Ore-Deposition. Walter P. Jenney. A study of the action of carbon and hydrocarbons, their combinations, and the relative reducing power of minerals. 17700 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 54625 D.

Petroleum.

The Russian Petroleum Trade. Information regarding the production of crude oil in the Baku fields, prices at the wells, refining, transportation, new fields, &c. 6700 w. U S Cons Repts, No. 1609—April 1, 1903. No. 54458 D.

The Present Oil Situation in Colorado. Prof. Arthur Lakes. A review of the histories of the several regions, and the discoveries which have been made. Ill. 3200 w. Mines & Min—April, 1903. No. 54442 C.

St. Louis Fair.

Mining and Metallurgy at the St. Louis World's Fair, 1904. Prof. Joseph A. Holmes. Information in regard to the proposed exhibits and what they are intended to show. 1200 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 54621.

Stamp Cams.

See Mechanical Engineering, Power and Transmission.

Zinc.

Zinc Industry in Europe. Information on the production and consumption of zinc in various European countries. 4000 w. U S Cons Repts, No. 1625—April 20, 1903. No. 54702 D.

The Zinc Mines at Ellenville, N. Y. Axel O. Ihlseng. Plan of the mine with brief account of the development. 500 w. Eng & Min Jour—April 25, 1903. No. 54928.

Zinc Works.

See Mining and Metallurgy, Coal and Coke.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in February. Condensed record of the principal accidents, with notes on the more serious ones. 3000 w. R R Gaz—April 3, 1903. No. 54555.

Train Accidents in the United States in March. A condensed record of the principal accidents, with remarks. 2500 w. R R Gaz—April 24, 1903. No. 54925.

A Remarkable Accident. Brief illustrated account of the collapse of a bridge span in Arizona, while a train was passing. 600 w. Ry Age—April 10, 1903. No. 54680.

MOTIVE POWER AND EQUIPMENT.

Bearings.

"Anti-Friction" Car Side Bearings and Center Plates. Gives results of tests made on the Pittsburg & Lake Erie road, showing a marked effect on train resistance. 700 w. Am Eng & R R Jour—April, 1903. No. 54479 C.

Coal Car.

Canadian Pacific Coal Car. Illustrated description of cars of 40 tons capacity, of the latest design, aiming to eliminate all tendencies toward sagging or bulging. 600 w. Loc Engng—April, 1903. No. 54453 C.

Fuel.

Petroleum Oil vs. Coal as Fuel. Arguments favoring the use of oil. 600 w. Loc Engng—April, 1903. No. 54455 C.

Locomotive Frame.

The Locomotive Steel Frame and Its Repairs. A. W. McCaslin. Presented before the Ry. Club of Pittsburg. Discusses the many failures of steel frames and how the repairs should be made. 2500 w. Ry & Engng Rev—April 25, 1903. No. 54959.

Locomotives.

A Caledonian Locomotive Giant. Charles Rous-Marten. States the conditions to be met, and gives illustration and description of the engine designed. 2000 w. Engr, Lond—April 3, 1903. No. 54661 A.

Acceleration and Velocity Curves Obtained with the New Midland Compound Express Engines. Gives interesting diagrams showing the accelerating power of the fine three-cylinder compound engines recently put on this line. 500 w. Engng—March 27, 1903. No. 54512 A.

American and Foreign Locomotives. Editorial discussing points in these locomotives, methods of drafting in America, and other points of interest. Gives particulars of the performance of foreign engines also. 2000 w. Loc Engng—April, 1903. No. 54454 C.

Atlantic Type Locomotive for the Baden State Railways (Locomotive Type "Atlantic" des Chemins de Fer de l'Etat Badois). F. Barbier. An illustrated description of a four-cylinder-compound, Atlantic-type locomotive built by Maffei, of Munich. 1 Plate. 2500 w. Génie Civil—March 14, 1903. No. 54861 D.

Atlantic Locomotive for Pennsylvania Lines. Illustrated description of the class E-2a engines, for the Northwest system of the Pennsylvania lines. General dimensions are given. 1000 w. Ry Age—March 27, 1903. No. 54428.

Experimental Tandem Compound Freight Locomotive. Illustrates and describes an engine of the 2-8-0 type, class G-2a for freight service. 1400 w. Am Engr & R R Jour—April, 1903. No. 54477 C.

Four-Cylinder Compound Locomotives for the Jura-Simplon Railway (Note sur la Locomotive Compound à 4 Cylindres de la Compagnie des Chemins de Fer du Jura-Simplon). Camille Barbey. An illustrated description of compound locomotives, with three pairs of drivers and a bogie truck forward, built at Winterthur, and also a plan and profile of the Jura-Simplon Railway through Switzerland. 2 Plates. 2000 w. Rev Gén des Chemins de Fer—April, 1903. No. 54850 H.

Four Cylinder Compounds in Europe. Reginald Gordon. Illustrates an engine showing recent German practice, and gives comparative tables showing weights and dimensions of four-cylinder compound locomotives. 800 w. R R Gaz—April 10, 1903. No. 54593.

Great Eastern 3-Cylinder 10-Wheeled

Coupled Tank Engine. Illustrated description of an engine designed for accelerated service on a suburban system. 1000 w. Mech Engr—April 4, 1903. No. 54643 A.

Locomotive Construction in the United States. A review of information from the census report with interesting comments on the conditions which necessitated great changes in the railroad transportation systems. 3000 w. Sib Jour of Engng—April, 1903. No. 54627 C.

Locomotives for the Mediterranean Railway. Illustrates and describes recently completed engines of the compound type, having four axles coupled and a four-wheeled bogie. They were designed for heavy trains on mountain lines. 1000 w. Engng—March 27, 1903. No. 54514 A.

Mikado (2-8-2) Compounds for the Atchison. Illustrated detailed description of Vauclain compound freight locomotives to be used on a mountain division having a maximum grade of 185 ft. per mile. 600 w. R R Gaz—April 3, 1903. No. 54552.

Recent Types of Powerful British Goods Locomotives. Illustrations and brief account of some of the recent types of goods locomotives built for work on British systems. 2500 w. Transport—April 3, 1903. No. 54637 A.

Rock Island Consolidation (2-8-0) Locomotive. Illustrated general description with notes on the features of interest. 700 w. R R Gaz—April 17, 1903. No. 54757.

Motor Car.

A Steam Railway Coach. Illustrations, with brief description, of a new steam-driven motor coach to be run on English railways. 500 w. Engr, Lond—April 10, 1903. No. 54723 A.

Train Resistance.

New Determinations of the Resistance of Locomotives and Trains at High Speeds (Neuere Ermittlungen über die Widerstände der Lokomotiven und Bahnzüge mit Besonderer Berücksichtigung Grosser Fahrgeschwindigkeiten). Prof. Albert Frank. Discussions of experiments made on railways in Hanover to determine frictional, air and other resistances of locomotives and trains at speeds up to 100 kilometers an hour. Diagram. 4000 w. Zeitschr d Ver Deutscher Ing—March 28, 1903. No. 54804 D.

Valve Design.

Proposed Design of Locomotive Valves for High Speeds. J. V. N. Cheney. A brief discussion giving the writer's views. 900 w. R R Gaz—April 10, 1903. No. 54594.

Wheels.

The Ehrhardt Patent Seamless Spoke-Wheel. R. M. Daelen. Describes this wheel and states the advantages claimed. 700 w. Ir & Coal Trds Rev—April 3, 1903. No. 54652 A.

Chilled Cast Iron Car Wheels. C. H. Vannier. Read before the students of Purdue Univ. Detailed description of the method of manufacture, and testing, with remarks. 5000 w. Foundry—April, 1903. No. 54602.

NEW PROJECTS.

Australia.

South Australia's Land-Grant Railway. Hon. J. H. Gordon. Discusses this scheme for the construction of a railway across Australia. Map. 2400 w. Rev of Revs—April, 1903. No. 54467 C.

Denver-Salt Lake.

Geology and Economics Along the Line of the New Moffat Railway to be Built from Denver to Salt Lake City. Prof. Arthur Lakes. Map and brief description of an interesting region both geologically and economically. 1500 w. Mines & Min—April, 1903. No. 54444 C.

Location.

Some Theories upon Railroad Location. J. G. Kerry. A discussion of factors of importance, especially from a Canadian point of view. Maps. 11000 w. Can Soc of Civ Engrs, Adv Proof—March, 1903. No. 54545 D.

Seaham-Hartlepool.

The New Seaham and Hartlepool Line. Brief illustrated description of a line 9½ miles in length, which gives much easier gradients, and opens a new coal field. An important addition to the North-Eastern Railway System of England. 2200 w. Transport—April 3, 1903. No. 54636 A.

Transandine.

The Transandine Railway. An illustrated description of the finished portion on the Argentine side of this interesting new line which will connect with the State railways of Chile. 1500 w. Ry & Engng Rev—April 11, 1903. No. 54681.

Trans-Canada.

The Trans-Canada Railway. E. T. D. Chambers. A discussion of this projected line, the directness of the route, its military importance, high altitudes, &c. Map. 2000 w. Rev of Revs—April, 1903. No. 54466 C.

Wabash.

The Greater Wabash. An illustrated general account of the new construction extending the Wabash railroad to Pittsburg and the coast. 2500. Ry Age—April 24, 1903. No. 54960.

PERMANENT WAY AND FIXTURES.

Albula.

The Albula Railway from Thusis to St. Moritz, Switzerland (Die Albula-Bahn von Thusis nach St. Moritz). H. Cox. An illustrated description of the construction of a railroad through a very difficult mountain region, involving many bridges and tunnels, the main tunnel being 5866 meters long. Map and profile. 1500 w. Zeitschr d ver Deutscher Ing—March 21, 1903. No. 54801 D.

Coal Pockets.

Local Coal Pockets for the Lehigh Valley R. R. at Newark, N. J. Walter G. Berg. Illustrated detailed description of recently constructed pockets with modern improvements. 1200 w. Eng News—April 2, 1903. No. 54549.

Drainage.

Drainage of English Railroads. Edward Davy Pain. An illustrated article showing typical methods of treating slopes and of draining cuttings. 2700 w. R R Gaz—April 3, 1903. No. 54554.

Erie Terminals.

New Erie Terminals at Jersey City and New York. An illustrated account of extensive changes to be made in Jersey City and Manhattan, including ferry-houses, office building, new station, tracks and yards, &c. 1300 w. R R Gaz—April 24, 1903. No. 54924.

Fencing.

Railway Fencing. R. W. Leonard. A discussion of this subject, the most economical and efficient type, cost, &c. Also considers cattle guards. 1600 w. Can Soc of Civ Engrs, Adv Proof—April, 1903. No. 54708.

Russia.

Railway Construction in Russia. Details from an historical sketch of the rise and progress of the Russian railway system, published in a recent number of the Russian *Official Messenger*. 1300 w. Engr, Lond—March 20, 1903. No. 54404 A.

Shops.

Car Shops of the Rochester Railway. An illustrated detailed description of new shops, equipped for car building and for the construction and repair of apparatus. 4200 w. St Ry Jour—April 11, 1904. No. 54677 D.

Improvements at the Topeka Shops of the Atchison, Topeka & Santa Fé Ry. Illustrates and describes the plans for a complete reconstruction and rearrangement of a plant for heavy locomotive work. 4500 w. Eng News—April 2, 1903. No. 54547.

Shop Improvements of the Pennsylvania at Columbus. An illustrated description of the extensive improvements of the general shops at Columbus, Ohio. 1700 w. Ry & Engng Rev—April 11 and 17, 1903. Serial, 2 parts. No. 54682.

Signals.

Automatic Signal Location. Shows the importance of the proper location, calling attention to points that should be considered. 2000 w. Ry Age—April 3, 1903. No. 54540.

Low Pressure Power Interlocking at Salisbury, England. Drawings showing the layout of tracks with description of the working. 900 w. R R Gaz—April 3, 1903. No. 54553.

The Safe Course. Charles Hansel. Arguments favoring the equipping of railroads with automatic signals and showing that a successful system must be designed to be a check on the engineer, but not to supersede him. 1800 w. Eng News—April 2, 1903. No. 54548.

See also Street and Electric Railways.

Tunnel.

See Civil Engineering, Construction.

Turn-Table.

Pneumatic Turntable. Illustrates and describes a high-speed compressed air turntable recently installed at Trenton, N. J. 600 w. R R Gaz—April 17, 1903. No. 54758.

TRAFFIC.

Rates.

Equated Tonnage Rates—Methods of Test and Calculation. Max H. Wickhorst. A discussion of engine rating; methods of determining the tractive force, friction, train resistance, &c., giving tables and diagrams. Also general discussion. 12000 w. W Ry Club—March 17, 1903. No. 54703 C.

Railway Freight Rates. J. N. Faithorn. An address before the College of Engng. of the Univ. of Wisconsin. Gives a general description of rate adjustments made necessary by changed conditions, outlining the prevailing systems. 5400 w. Wis Engr—Feb., 1903. No. 54606 D.

MISCELLANY.

Accounting.

The Distinction Between Repairs and Improvements, and a Proposed Classification of Railroad Maintenance of Way Expenses. Walter G. Berg. Abstract of a paper before the Am. Ry. Engng. & Maintenance of Way Assn. 1500 w. Eng Rec—April 4, 1903. No. 54559.

Tests.

Test Departments. C. W. Gennet, Jr. Considers the object of the test department in railroading, and the method of carrying on the work. 2400 w. R R Gaz—April 10, 1903. No. 54592.

STREET AND ELECTRIC RAILWAYS

Boston.

The Street Traffic in the City of Boston. Charles Prelini. An illustrated article describing the conditions and the difficulties, and the construction of the subway. 7700 w. Trac & Trans—April, 1903. Serial. 1st part. No. 54901 E.

See also Civil Engineering, Construction.

Cincinnati.

The Cincinnati, Georgetown & Portsmouth Railroad Changed from Steam to Electric Traction. E. M. Stevens. Illustrates and describes the electrical apparatus installed, the power plants and substations. 2500 w. Elec Rev, N Y—April 4, 1903. No. 54535.

Colorado Springs.

The Colorado Springs & Interurban Street Railway System. J. H. Rusby. An illustrated description of the electrical equipment and the power installation. 2000 w. Elec Rev, N Y—April 25, 1903. No. 54787.

Flat Cars.

Working Drawings for an Electric Flat Car. Arthur B. Weeks. Description with drawings. 700 w. St Ry Jour—April 25, 1903. No. 54932 D.

Germany.

Transportation Problems and Progress in Germany. Reports a constant improvement, considering the development of the Berlin electric railways, the State railways and electric traction on canals. 2000 w. U S Cons Repts, No. 1618—April, 1903. No. 54598 D.

High Speed.

High Speed Electric Traction. Arthur L. Cook. Reviews the various systems that have been brought forth and the types of apparatus employed, and discusses the classes and apparatus best suited to each. 8300. Jour Worcester Poly Inst—March, 1903. No. 54604 C.

London.

Locomotion and Transport in London. Edward Davy Pain. An account of the task awaiting the Royal Commission which was appointed to investigate and report concerning means of locomotion and transport. 3000 w. R R Gaz—April 24, 1903. No. 54923.

The Movement of London. T. C. Elder. A statement of conditions in London, and the traffic problems. A discussion of the work to be undertaken by the Royal Commission. 3600 w. Trac & Trans—April, 1903. No. 54902 E.

Mersey Railway.

The Electrification of the Mersey Railway. Gives a review of the history of this tunnel railway connecting Liverpool with Birkenhead, and an account of the recently completed electrification of the entire line. 4000 w. St Ry Jour—April 4, 1903. No. 54563 D.

Multiple Unit.

The Sprague Multiple-Unit System of Electric Traction (Le Système Sprague pour la Commande des Trains Electriques à Motrices Multiples). Jean de Traz. A comprehensive account of this electric traction system, with many diagrams and illustrations. 6500 w. Bull Soc Internationales des Electriciens—March, 1903. No. 54848 H.

New York.

Rapid Transit in New York. Hon. Robert P. Porter. An outline of the schemes under way and prospected in New York, with comments. 2500 w. Engng—April 10, 1903. No. 54726 A.

New York Subway.

The Subway of New York. Charles Prelini. Comments on the plan presented by William Barclay Parsons, and of other improvements in transportation facilities. 2000 w. Engng—March 27, 1903. No. 54510 A.

New Zealand.

The Auckland Electric Tramways. An illustrated detailed description of electric lines recently constructed in this flourishing town in New Zealand. 3500 w. Tram & Ry Wld—March 12, 1903. No. 54420 B.

Ohio.

Ohio Central Traction System. An illustrated description of the construction and operation of the Mansfield, Crestline and Galion line, which is a part of this system. 2800 w. St Ry Jour—April 25, 1903. No. 54931 D.

Operation.

Possibilities in the Direction of Improving Operating Practice. Remarks on benefits derived from inspection tours to other shops and from good railway literature. 3000 w. St Ry Jour—April 25, 1903. No. 54934 D.

Paris Metropolitan.

The North Circular Section of the Paris Metropolitan Railway (Le Chemin de Fer Metropolitain de Paris, Ligne Circulaire, Nord par les Boulevards Exterieurs). Raymond Gadfernoux. A well illustrated

We supply copies of these articles. See page 475.

description of the section of the Metropolitan electric railway of Paris, which follows the line of the northern exterior boulevards, partly in viaduct, but principally underground. 3 Plates. 6500 w. Rev Gén des Chemins de Fer—April, 1903. No. 54849 H.

Philadelphia.

The Philadelphia Rapid Transit System. W. W. Wheatley. Explains the organization and growth of the system, reports expenses, earnings, &c., in the present issue. Ill. 3300 w. St Ry Jour—March 28, 1903. Serial. 1st part. No. 54434 D.

Subway Structures of the Philadelphia Rapid Transit Company. Illustrated detailed description of the proposed construction of a concrete steel subway. 2500 w. Eng Rec—April 18, 1903. No. 54765.

Pittsburg, Pa.

The Street Railway System of Pittsburg, Pa. An illustrated article giving information of the finances, lines, rolling stock, power plants, &c. 9000 w. St Ry Rev—April 20, 1903. No. 54772 C.

See also Civil Engineering, Canals, Rivers and Harbors.

Rockford-Janesville.

Rockford, Beloit & Janesville Railroad—Power Plant, Operation and Equipment. Illustrates and describes an interurban road, in Illinois and Wisconsin, supplied by alternating-current transmission with rotary converter substations. Gives records of the power house and substation performance. 2500 w. St Ry Jour—April 25, 1903. No. 54933 D.

San Francisco.

New Power Plans of the United Railways of San Francisco. Illustrates and describes the new central power station and its equipment, and the three substations which are now in course of construction. 3300 w. St Ry Jour—April 18, 1903. No. 54749 D.

Signalling.

Signalling on Single Line Tramways. Lionel E. Harvey. Brief account of hand-operated and automatic systems in use. 1300 w. Elec Rev, Lond—April 17, 1903. No. 54945 A.

Snow.

Snow Fighting in Buffalo. Illustrates and describes the snow-fighting apparatus used. 1800 w. St. Ry Jour—March 28, 1903. No. 54435 D.

Speeds.

Schedule Speeds on Electric Railways. W. Park. A study of the maximum schedule speed, and things affecting it. 1100 w. Tram & Ry Wld—March 12, 1903. No. 54422 B.

Standard Railways.

The Electric Operation of Standard Railways (Neues aus dem Gebiete Elektrischen Betriebes für Vollbahnen). Hr. Reichel. An illustrated paper before the "Verein für Eisenbahnkunde" on high-speed electric railways for heavy traffic, with high voltages, with reference to the zossen and other German experimental work. 7000 w. Glasers Annalen—April 1, 1903. No. 54823 D.

Electric Traction on Steam Railways. Alton D. Adams. Discusses the systems tried, their cost, advantages and disadvantages. 2200 w. Cassier's Mag—April, 1903. No. 54464 B.

Stray Currents.

See Electrical Engineering, Electro-Chemistry.

Surface Contact.

The Schuckert Surface Contact Tramway System. Brief illustrated description of this system which is to be tested in England. A trial section in Munich was pronounced satisfactory. 2000 w. Engng—March 27, 1903. No. 54511 A.

Schuckert Surface Contact System. An illustrated description of the present designs as a whole, improvements having been recently made. 1600 w. Tram & Ry Wld. March 12, 1903. No. 54423 B.

Third Rail.

Third Rail Contact. George T. Hanchett. Discusses the troubles caused by sleet accumulations, and calls attention to some practical experiences which have reference to the commercial practicability of the third rail and contact shoe. Describes devices tried and offers suggestions. 2000 w. Tram & Ry Wld—March 12, 1903. 54421 B.

Tokyo.

Tokyo Street Railway and Foreign Capital. A draft of the agreement by which a British syndicate will supply the Japanese company with needed capital; also some information regarding the attitude of the Japanese to foreign capital. 1000 w. Engr, Lond—March 20, 1903. No. 54405 A.

Tunnel.

See Civil Engineering, Construction.

Valtelline.

High Tension Polyphase Electric Traction as Applied on the Valtelline Railway [Traction par Moteurs Triphasés à Haute Tension (Système Ganz et Cie.) Appliquée sur la Ligne de la Valteline]. D. Korda. An illustrated comprehensive article on the Valtelline electric railway in Italy, built on the Ganz tri-phase system, and a discussion of high tension polyphase traction in general. 10,000 w. Bull Soc Internationale des Electriciens—March, 1903. No. 54847 H.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.

Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* Philadelphia.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Feilden's Magazine. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Straussenbahnen. *s-m.* Berlin.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* Chicago.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Electrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

Note—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to The Engineering Magazine.

Coal Strike Report.

Report of the Anthracite Coal Strike Commission. Bulletin of the Department of Labor. No. 46—May 1, 1903. Edited by Carroll D. Wright. Size, 9 by 5¾ in.; pp. vi, 247. Washington, D. C.: The Department of Labor.

This Commission was appointed by the President of the United States to consider the questions at issue between the coal miners and the operators which led up to the great strike of 1902, and to make awards which should be binding for three years. While abstracts of this report were given in newspapers and other periodicals upon its issue, so that its general tenor is well known, it is nevertheless very interesting and instructive to read the unabridged version, with its various appendices. The report proper gives a general review of the conditions in the anthracite coal regions, and a history of events leading up to the strike. The testimony presented before the Commission is then discussed, and the awards are given in full, together with the reasons which were determining with the Commissioners,, who were Judge George Gray, Gen. John M. Wilson, Bishop John L. Spalding, Mr. E. W. Parker, Mr. E. E. Clark, Mr. Thomas H. Watkins, and Col. Carroll D. Wright, as recorder. The appendices contain the statements of the parties to the case; the earnings of mine workers; details of mine operation; constitution of the United Mine Workers of America; a plan, proposed by the Commission, for an organization for the execution of trade agreements; a bill, proposed by Mr. Charles Francis Adams, providing for compulsory investigation and publicity, and other matter. Altogether, the report is one of the most important contributions to the discussion of the labor question that has ever been made, and should be carefully studied no less by the business man and manufacturer than by the sociological student.

Electro-Chemistry.

Kalender für Elektrochemiker, sowie Technische Chemiker und Physiker für das Jahr 1903. VII. Jahrgang. With supplement. By Dr. A. Neuburger. Size, 6½ by 4½ in.; pp. 583, in supplement, 448; figures and tables. Price, 4 marks ($1.25). Berlin: M. Krayn.

Since the first edition of this calendar and hand-book was issued in 1896, the practical applications of electro-chemistry have increased enormously, and in the present edition of this work a successful effort has been made to keep pace with the advance of the industry. The calendar occupies only a small portion of the book, the greater part of which, as well as the whole of the supplement, being filled with tables and information useful to electro-chemists in particular, and also to chemists and physicists in general. Among the topics treated are: Electrical units and measurements; atomic weights; specific weights; solubility; chemical analysis; electrolysis; conductivity of electrolytes; polarization; electromotive forces of various cells; electro-chemical and thermo-electric generation of currents; accumulators; quantitative electrolysis; technical electrolysis, and various branches thereof; mathematical tables; physics, including general mechanics, heat and optics; technical mechanics and machines; fuels and heating; patents laws of Germany, and of the other leading states; other German laws and regulations, and general information.

Induction Motor.

The Induction Motor, Its Theory and Design Set Forth by a Practical Method of Calculation. By Henri Boy de la Tour. Translated from the French by C. O. Mailloux, M. A. I. E. E., M. I. E. E. Size, 9¼ by 6¼ in.; pp. xxvii, 200; figures, 75. Price, $2.50. New York: McGraw Publishing Co.

The object of this work, as stated in the preface, is "to give a complete study of the polyphase non-synchronous (induction) motor, and to explain at length all the peculiarities of its operation, while remaining within the bounds of elementary mathematics." The author is well and favorably known in Europe as a contributor to the French elecrical periodicals, being an authority on the subject discussed in the present volume, and he is now introduced to the English-reading public under most favorable auspices, as the translator is peculiarly fitted for his work, both from a technical and a linguistic standpoint. After a review of the theory of the revolving (or rotary) field, the principles of the induction motor are taken up and its design worked out analytically and graphically, with a free use of figures and diagrams. Many details and modifications are considered, so that the work will be especially valuable to the designer who is obliged to satisfy the requirements of everyday practice. At the request of the translator, the author has prepared, for this American edition, a chapter on the Heyland induction motor, which is designed to operate with a power factor of unity under all loads. The translator, in an interesting introduction, has made a valuable contribution to technical nomenclature, discussing the meanings and definitions of various words used in both the French original and the English translation. This not only prevents any ambiguity in the meaning of the terms employed in this book, but also helps to give greater exactness and clearness to electrical terminology in general.

Irrigation.

Irrigation Institutions. A Discussion of the Economic and Legal Questions Created by the Growth of Irrigated Agriculture in the West. By Elwood Mead, C. E., M. S. Size, 7½ by 5¼ in.; pp. xi, 392. Figures. Price, $1.25 (postage, 12 cts.). New York: The Macmillan Company. London: Macmillan & Co., Ltd.

The opening years of the twentieth century have brought a larger and truer conception of the value of the arid West and of the part it is to play in the industrial life of the United States. The American nation has been awakened to the opportunities here presented, and the civic pride of Western communities has been aroused to secure the creation of irrigation codes which will be worthy of a self-governing people. As an aid to local effort, the general government is engaged in gathering facts on which future developments should be based. The Department of the Interior is measuring the water supply, and the Department of Agriculture is studying the methods of distributing and using water in order to promote its more skilful and effective use, and is inquiring into the social and legal questions created by the use of streams in irrigation, both in the United States and in other countries. From its beginning the author has been in charge of the latter investigation, and the present work is based on his twenty years of experience in the development of irrigated agriculture in the West. The lessons of these years is that the vital agricultural problem of the arid West is to establish just and stable titles to water and provide for their efficient protection in times of need, and the purpose of this book is to lead to a better understanding of this problem and so to further its wise and just solution. After several chapters devoted to a general review and discussion of irrigation in the western part of America, the conditions prevailing in the several arid States are described, and a concluding chapter treats of the methods and measures needed for future development. This volume forms one of the "Citizens' Library of Economics, Politics and Sociology," and will prove of great interest to all who are concerned with irrigation, and particularly to those who have the growth and prosperity of the Western United States at heart.

Mechanics.

An Elementary Treatise on the Mechanics of Machinery, With Special Reference to the Mechanics of the Steam Engine. By Joseph N. Le Conte. Size, 7¾ by 5½ in.; pp. x, 311; figures, 212; plates, xv. Price, $2.25. New York: The Macmillan Company. London: Macmillan & Co., Ltd.

The present work is the outcome of a course of lectures on kinematics and the mechanics of the steam engine, which has been issued in the form of notes to students in the department of mechanical engineering of the University of California for several years past. The first two parts embody the more important principles of what is generally called the kinematics of machinery, though in many instances dynamic problems which present themselves are dealt with, the real purpose of the book being the application of the principles of mechanics to certain problems connected with machinery. In the third part is discussed the mechanics of the steam engine, that machine being considered perhaps the most important from a designer's point of view. Here the subject is treated under two distinct heads, kinematics and dynamics. Appendices contain discussions and proofs of problems and theorems in kinematics, and an index completes a volume which makes a highly satisfactory text-book, the topics being well handled and clearly illustrated.

Railroad Construction.

Railroad Construction. Theory and Practice. A Text-Book for the Use of Students in Colleges and Technical Schools. By Walter Loring Webb, C. E. Second edition. Size, 6¾ by 4½ in.; pp. xvii, 675; figures, 232, including halftones and folding plates. Price, $5. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The first edition of this book was issued about three years ago in octavo size, but as this form was inconvenient for use in the field, it was decided to recast the whole work and reduce the page to pocket-book size. Advantage was taken of the opportunity to revise freely and to add new matter, the original text being now almost doubled. Among the new chapters are some on structures, train resistance and rolling stock, and several giving the fundamental principles of the economics of railroad location. The latter make up the second part of the book, and supply, in clear and interesting form, extremely valuable information, which is too often neglected by engineers, and particularly by young ones, who concentrate their attention upon the technical side of railroading, when the economic side is often of superior importance. Other chapters treat of surveys, and the construction of the permanent way, with accounts of the most modern forms of superstructure, block signaling, brakes, etc., the sections on earthwork and on transition curves being particularly full and valuable. There are many useful tables in convenient form, a good index and a large number of illustrations. While the book is intended primarily for students, it will prove very useful to any railroad engineer, in either the field or the office.

Railway Engineers.

Manual for Resident Engineers, Containing General Information on Construction. By F. A. Molitor and C. J. Beard. Size, 7½ by 4¾ in.; pp. iv, 118; plates, diagrams and tables. Price, $1. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The authors of this book are, respectively, the chief engineer and the principal assistant engineer of the Choctaw, Oklahoma and Gulf Railroad, and in the course of the construction of this company's lines they first issued part of the present volume in blue-print form and afterwards published the whole in book form for the use of their road, with the satisfactory result that each of the fifty or more resident engineers was able, without verbal explanations and instructions, to comply with the standards required, and to obtain uniformity of method in both work and results. The first part of this manual contains general information on construction, reports and the duties of resident engineers. This is followed by standard general specifications for graduation, masonry and lumber, and an abstract of a general form of contract, and in the latter portion of the book are tables of level cuttings, to be used for preliminary work only, giving the cubic yards in prismoids 100 feet long for various breadths of base and heights. This convenient little manual, which has been so useful on one railroad, should now prove of equal service to the railroad engineering profession in general, and will no doubt receive the welcome it deserves.

Steel Analysis.

The Analysis of Steel Works Materials. By Harry Brearley and Fred Ibbotson. Size, 9 by 6 in.; pp. xv, 501; figures, 85. Price, 14s. ($5). London, New York, and Bombay: Longmans, Green & Co.

In this volume the analysis of steel-works materials is dealt with on such lines as could profitably be followed in a large and busy works laboratory, so that the book is an eminently practical one and should prove most useful to steel-works chemists, besides being an excellent text-book for students. The different parts are devoted to the analysis of steel; analysis of pig iron; analysis of steel-making alloys; rapid analysis at the furnace; analysis of ores; analysis of refractory materials; analysis of slags; analysis of fuel; boiler water, boiler scales, etc.; analysis of engineering alloys, including copper alloys and white metal alloys; micrographic analysis of steel; pyrometry, and miscellaneous notes. In the part on micrographic analysis, there is A. L. Colby's complete bibliography of works on the metallography of iron and steel, published before the foundation of the *Metallographist,* and an appendix to the volume contains a comprehensive bibliography of steel-works' analysis compiled from the *Chemical News, Journal of the Society of Chemical Industry, Journal of the Iron and Steel Institute,* and *Journal of the Chemical Society.* There are illustrations of apparatus and a number of good micrographs, and the book, besides its intrinsic merit, has an attractive appearance and is very well made.

Steel Treatment.

Hardening, Tempering, Annealing and Forging of Steel. By Joseph V. Woodworth. Size, 9¼ by 6 in.; pp. 288; figures, 201. Price, $2.50. New York: Norman W. Henley & Co.

In preparing this work the author has paid particular attention to the requirements of the metal-working mechanic, and has written a treatise on the practical treatment and working of high and low grade steel, comprising the selection and identification of steel, the most modern and approved heating, hardening, tempering, annealing and forging processes, the use of gas-blast forges, heating machines and furnaces, the annealing and manufacturing of malleable iron, the treatment and use of self-hardening steel, with special reference to case-hardening processes, the hardening and tempering of milling cutters and press tools, the use of machinery steel for cutting tools, forging and welding, high-grade steel forgings in

America, forging of hollow shafts, drop-forging, and grinding processes for tools and machine parts. With the object of giving to practical men a book describing the treatment of steel for tools of all kinds, the author has drawn upon a personal experience of many years, and has, besides, gathered and arranged all available information from other sources. The uses to which the leading brands of steel may be adopted are discussed, and their treatment for working under different conditions explained, and in the volume are various "kinks" and practical points which help to make it useful to the metal worker and machinist. Considering the revolution which is being made in machine-shop practice by the introduction of the new high-speed tool steels, this work is a most timely and valuable one, as it gives some of the latest information concerning the manufacture and employment of this modern material.

Wood.

The Principal Species of Wood: Their Characteristic Properties. By Charles Henry Snow, C. E., Sc. D. Size, 10½ by 7 in.; pp. xvi, 203; figures in the text and 39 full-page half-tones. Price, $3.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

In this book the most important species of wood, from an economic standpoint, are described and illustrated, and their principal characteristics are discussed. The order of procedure followed here is to give a general and historical sketch of the genus, with illustrations of the full-grown tree, leaves, nuts, and bark, and sections of the wood. The principal species are then taken up and their following characteristics are detailed: Nomenclature; locality; features of trees; color, grain or appearance of wood; structural qualities of wood; representative uses of wood; weight of seasoned wood; modulus of elasticity; modulus of rupture; general features. Among the genera thus treated are: Oak; ash; elm; maple; walnut; hickory; chestnut; beech; sycamore; birch; locust; tulip-tree; poplar or cottonwood; willow; catalpa; buckeye; teak; mahogany; eucalyptus; pine; spruce; fir; hemlock; cedar; cypress; redwood; palm; and bamboo. Most of the woods here considered are those native to North America, and, as before remarked, emphasis is laid particularly upon their engineering and economic qualities. The data are derived from the author's own observations, from U. S. Government reports and from other standard sources. There is a bibliography and an index. The book is well made, has some fine illustrations, and should prove a valuable contribution to the literature of engineering materials.

Yacht Building.

Small Yacht Construction and Rigging. By Linton Hope. Size, 9½ by 6½ in.; pp. 177; plates 4; many illustrations and figures. Price, $3. New York: Forest and Stream Publishing Co.

Boat building is a very interesting hobby, and for yachtsmen who are desirous of gaining that intimate knowledge of their boat which is obtained only by constructing it themselves, this book will prove a helpful guide. The first part of the volume, after giving general directions about tools, materials and methods of construction, contains complete designs for two boats: a 22-foot, center-board, jib-and-mainsail boat, and a 24-linear-rating fast cruiser, with topsail-sloop rig and a small cabin. The second part relates particularly to the rigging, and describes different sail plans and gives their comparative advantages and disadvantages. The metal work and various other details are treated fully, and many illustrations help to make the book a useful one for the amateur yacht builder.

BOOKS ANNOUNCED.

The Copper Handbook. 1903 Edition. By Horace J. Stevens. Price, $5 (in buckram), $7.50 (in full morocco). Houghton, Mich.: Horace J. Stevens.

Statics by Algebraic and Graphic Methods, Intended Primarily for Students of Engineering and Architecture. By Lewis J. Johnson, C. E. Price, $2. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The Improvement of Rivers. A Treatise on the Methods Employed for Improving Streams for Open Navigation, and for Navigation by Means of Locks and Dams. By B. F. Thomas and D. A. Watt. Price, $6 (postage, 47 cents). New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

A Handbook on the Steam Engine. Third English Edition, Revised. By Herman Haeder. Translated from the German by H. H. P. Powles. Price, $3. New York: D. Van Nostrand Company. London: Crosby, Lockwood & Son.

Heating and Ventilating Buildings. A Manual for Heating Engineers and Architects. Fourth edition. By Rolla C. Carpenter, M. S., C. E., M. M. E. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Gold Dredging, the New Industrial. Price, 25 cents (paper), 50 cents (cloth). Chicago: Bunting & Van Asmus.

Ninth Annual Report of the Commissioner of Public Roads for the Year Ending October 31, 1902. Trenton, New Jersey: Office of Commissioner of Public Roads.

THE ENGINEERING MAGAZINE

"THE WORLD IS ITS FIELD"

VOL. XXV. JULY, 1903. No. 4.

THE AUTOMOBILE AND THE RAILWAY AS TRANSPORT AGENTS.

By Sylvester Stewart.

THE poet says of vice that we first endure and then embrace it. With the new discovery or improvement we first flout, then over-estimate it. For a long time after the successful introduction of the electric light it remained a prime favorite with forecasters who loved to tell how it was going to put out gas. Then came the bicycle which was to reduce greatly the earnings of street railways. Today the chief among the menacers of trembling stockholders in existing things is the automobile. Many editorials and other articles in newspapers and magazines tell us that this light locomotive running upon macadam is going to make great inroads on the business of the railways, and some of the prophets—among them no less a personage than Sir Henry Norman, M. P., editor of the English edition of *The World's Work*— predict that it will wipe out the railway.

Let us take for a text Sir Henry's article on "The Coming of the Railway" in the April number of his magazine, in which article he

Mr. Stewart's article was written and, indeed, in type, some time before the shocking fatalities of the Paris-Madrid race came to confirm so grewsomely one aspect of his conclusions. His letter, written since that event, appears in our Editorial Comment in this number.

It seems from certain reports, however, that it will take even more than that tragic lesson to teach some of the wrong-headed and dangerous advocates of the automobile what its true friends fully understand. That is, that the competition of the motor vehicle is not with the locomotive on rails at all; neither in economy of haulage nor in the practical attainment of sailed upon the clouds of enthusiasm till lost among the peaks of per-adventure. Other articles of the same tenor have since appeared (in one in *Munsey's Magazine* for May a writer says, "Fast as a locomotive may go an automobile may go faster"), but a reply to Sir Henry will serve as a reply to all writers equally deluded.

After predicting that "the automobile will kill the railway," Sir Henry asks:—"Why should the community pay a huge sum per mile for a special roadway [steel rails] for cars, and a huge generating station, when self-propelled motor omnibuses of equal speed, comfort, capacity, and economy can use the common road, and by their ability to be steered around obstacles, not interfere with the rest of the traffic?" and continues:—"Few of our leaders of opinion have yet realized that we are on the eve of a more momentous change than that inaugurated by Watt and Stevenson."

The traction or pull of a vehicle on the best macadam road is at least four times as great as on steel rails, and on some macadam roads it is eight times as great. The steel road is as much better than macadam as macadam is better than mud. The traction of a ball-bearing vehicle with large wheels and small axles could be reduced to four pounds per ton on level rails, making it possible for a rabbit, rooster, or tom cat to pull a man. A locomotive which cannot propel itself alone more than twenty-five miles per hour on the best macadam road, can pull a long train at that speed on steel rails, allowing it to use flangeless wheels on macadam and flanged wheels on rails.

Running cars on steel rails has changed the world more than any invention ever made, extending commerce, spreading civilization, promoting peace, unifying nations.

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speed in travel can it ever compete with, or even approach, the work of the locomotive. That work, as Mr. Stewart shows, is accomplished in connection with other elements quite as important to the result as the engine itself. These are the fixed railway, the minimizing of curve and grade, the movement of large units by a definite schedule, and not least, the absolute control of all movement by an elaborate signal system. And every one of these factors is wholly excluded by the essential theory of the automobile.

The field of the motor vehicle is one which scarcely overlaps at all that of the railway locomotive. It is one which it holds not by rivalry with the railway engine in fast running or cheap hauling, but by qualities of its own, which the heavier machine totally lacks. These are, in chief, freedom and individuality of movement and adaptability to small-unit service. As a "house-to-house" transport agency for freight or passengers beyond the network of the railway, or where the traffic is not dense enough for the railway, it is destined to be an invaluable adjunct, auxiliary, and supplement to the locomotive. Here it is supreme as a transport agency. But as a mile-a-minute road racer it is a nightmare and a Juggernaut; and the gentlemen who show us that a sixty-horse-power car can be sent a mile along an open road in three-quarters of a minute, much as we may marvel at their nerve, contribute not a whit more to the beneficent economy of the world's work than the other gentlemen who "loop-the-loop" on bicycles or dive from high platforms into shallow tanks. —The Editors.

That it is the steel rail more than the locomotive that has worked these wondrous changes is shown by the facts that the locomotive at work off of steel rails has accomplished very little, although it has been in actual or attempted use longer than the locomotive on rails, and that railways without locomotives (horse-railways and cable-railways) are able everywhere to carry passengers three to five times as far for a nickel, as any vehicle on any other kind of road; even though the vehicles on the common road have their roadway built and maintained for them free by the taxpayers, while the railway company has to maintain not only its track, but on city lines, the paving of the street between the rails, and to stand the wear of thousands of wagons using its rails, besides paying in many cases a large sum for its franchise.

As to freight, the average cost of hauling by road locomotives is at least 10 cents per ton per mile, but on railways it is only 7 mills (on the Pennsylvania railway ½ cent) and this charge covers the cost of maintenance of the track and interest on the original cost of construction, or double the cost of construction, if the stock was well watered, while as we have said, the roadway for the locomotive using the macadam is *built and maintained by the public.*

It may be said that it is the long haul and the haul on a large scale (long trains) which makes the one-half cent per ton-mile possible. Answer:—

1.—It is the steel rail which makes the long train possible. 2.—The short-haul rates are only one to two cents per ton-mile, or five times the speed and one-fifth to one-twentieth the cost by the road locomotive.

It may be asked by Sir Henry Norman or others, why the railway locomotive, if as efficient as I claim, does not pull passengers at a lower rate. Because it gives passengers so much room, comfort, and high speed, that it has to carry a ton of dead weight for each passenger. A locomotive weighing 100 tons pulls, at 45 miles per hour, 12 cars weighing 600 tons and containing 760 people, weighing 50 tons, assuming the passengers to be men, women and children, but chiefly men, and to average 131 pounds each; 1,400 pounds of dead weight per passenger, when every seat is taken. But cars cannot average more than seven-tenths full.

The railway carries free the passengers' 150-pound trunks, and sends with him toilet-rooms, heating stoves and fuel, smoking rooms, dining rooms, and bed rooms. These houses on wheels, and the locomotive which draws them, have to be made very heavy in order to get the great strength made necessary by high speed. If the railway could dispense with these comforts and luxuries, and carry passengers packed closely inside and on top of low-roofed, ramshackle, unheated vehicles, like the old stage, and at slow speed, it could pull passengers at one-tenth to one-twentieth the price of the old stage.

It has been said of the Pilgrim Fathers "We like them for ancestors, but would hate to have them for neighbors"; it could be said of the old stage "We like it for its picturesqueness, but we would hate to ride in it." We continue to admire it on condition that it will not return. I admit that for a short ride in fine weather the stage was, and the automobile is, enjoyable; but before a passenger can be well protected from dust, wind, rain, and cold, and furnished with pure air through openings 14 feet above the ground, as in a railway car, the automobile must be built as large and heavy as that car, which is a development not probable. Owing to the great weight of the housed-in car, automobiles are made open, or merely have carriage-tops, and trust to providence for weather. When I see an automobilist covered with mud and wet with rain, I think of the Scotchman who arose in a theater, after two hours of doleful tragedy, and asked the tragedienne, "Do you call this diversion?"

If the immense traffic of a long-distance railway, on which hundreds of trains must run at night, were transferred to a macadam road, that road would have to be lighted its entire length, or every vehicle would have to carry a light as powerful as, or more powerful than, the railway locomotive now carries. As a locomotive on macadam could not round curves with a train of more than two cars, it would be necessary to use ten to twenty times as many locomotives as now, which would mean much greater expense for light.

Having now replied to Sir Henry's claims of "equal comfort, capacity and economy," we come to the question of "equal speed." Here again the facts strike Sir Henry heavily and knock him out with fearful force. The highest speed (a mile in 46 seconds) made on macadam by a powerful automobile built especially for racing, with 70 or more horse power allowed for the propulsion of two men, has been far exceeded by locomotives on rails, hauling trains. How fast would the automobile go on a macadam road, if pulling a train of three cars, each as large as itself and filled with passengers, and how much dust would a man breathe in a day on that road, supposing as much traffic upon it as passes over some railways? Locomotives running alone have achieved a speed of 120 miles an hour.

As to "steering around obstacles," it is one of the great disadvantages of vehicles not on steel rails that they must be constantly steered around each other, thus pursuing a serpentine course, which adds to the distance and makes high speed dangerous. 60 miles per hour is safe on rails; 15 miles is dangerous on macadam, as would soon be realized if the immense traffic on one of our railways were thrown on to a macadam road. On a railway we see thousands of cars daily passing thousands of others, almost touching, yet so accurately guided by the rails that accidents are rare, and would be much rarer if we could be satisfied with 15 miles per hour, all that we could expect from passenger and freight vehicles running on macadam.

Sir Henry speaks of the "huge cost" of the railway. Considering the large traffic that can be carried on a steel track its cost is small. It would require five of the largest auto omnibuses now made to carry as many passengers as are packed in one trolley car. Again, the macadam road would cost much more than it does now if built to sustain mammoth autos carrying seventy passengers, the number that many trolley cars carry during rush hours. To carry passengers in small vehicles is too costly. One conductor and motorman must handle loads of fifty or more passengers. If the 100-ton locomotives now in use on railways were to run on macadam the deep stone foundation necessary to sustain them would make that road cost more than a railway, for the rails and cross-ties, by their length and stiffness, distribute over a considerable area the weight which, on a stone road, falls too heavily in one spot. It may be said that on account of the superior adhesion on macadam the locomotive running on it would need to weigh but half as much as if on rails to exert the same pull. But the pull on macadam is only one-fourth as effective as on rails, hence the road locomotive would have to weigh 200 tons, and use four times as much fuel as the railway locomotive in order to pull as heavy a train.

As to comparative cost of maintenance of roadway, there are not sufficient data on which to base a conclusion, but it is probable that a dollar's worth of steel will outwear a dollar's worth of macadam. The life of a traction engine is four or five years; the life of a railway locomotive is fifteen to thirty-five years. All roads but steel are hard on heavy engines.

As to "huge generating station," that is equally applicable to a rail or road locomtive system. It may be added to, or omitted from either.

As to a "change greater than that inaugurated by Watt and Stephenson," they inaugurated the running of motor vehicles on common roads, as well as on rails, for Watt invented the engine, and Stephenson successfully put it on wheels. They built for all roads, but Stephenson showed that the metal road permitted higher speed and lower rates than any other, even when the rails cost fourteen times as much, per degree of durability, as now. For, before the era of cheap steel, iron rails were used, rails which cost more than twice as much per pound as steel rails cost now, yet wore only one-seventh as long.

Vehicles have been greatly improved since Watt and Stephenson towered among the tiny ones, but the railway will gain as much as the common road from that. Ball-bearing vehicles have been so well perfected that they will run by gravity, on a first-class macadam road, down a grade of 32 feet to the mile. But on rails they will run by gravity down a grade of 8 feet to the mile, a grade so slight that, to the eye, it seems level. Ball-bearing vehicles on rails will in many cases, on farmers' railways on wide plains, carry sails for auxiliary power; and many vehicles will on light railways use only manual power and sails. These developments may wait till fuel becomes much dearer than now, but a sail which propels a boat 15 miles per hour, would, in the same wind, propel five times as much load at the same speed if the load were placed on ball-bearing cars on level steel rails. And the same effort that a man exerts in propelling himself 10 miles per hour on a bicycle on an ordinary macadam road would propel at least 800 pounds of butter, eggs, etc., at that speed on a properly constructed vehicle and railway. Or it would propel at least a ton at the rate of 4 miles per hour. We must either admit this or declare all reported traction tests to be falsehoods, and all engineering works to be romances.

That the automobile has a great future I do not deny. Its chief mission is to change city streets from manure yards to clean thoroughfares. The horse is unfit for use on city streets. He occupies too much space; he is too hard to steer; he has the wrong kind of feet on him; besides, on crowded streets, his worried driver whips, frets, and jerks 10 per cent. of his energy out of him, and shortens his life. Permitting horses in cities is cruel and wasteful, and is injurious to both horses and men.

But whatever efficiency the auto may attain by future improvements, it will always remain true, that if it is put on steel rails, the same engine and the same quantity of fuel necessary to pull ten passengers or one ton of freight on the best macadam road, will pull at least forty passengers or four tons of freight on steel. So, instead of "making railways obsolete," the auto will call for light steel rails for itself, in hundreds or thousands of localities, and will probably be equipped, in many cases, with guides, so that it can run either on or off rails.

The automobile, instead of being a menace to the railway, will be a feeder to it. Light railways—T rails, plateways, etc.,—will branch from main lines, and on these branches will run freight and passenger automobiles. The automobile's misfortune at present is the mistake of its admirers—their supposition that it can reach high efficiency on stone roads. It can for pleasure, but not for business. The best friend of this promising child is he who tells it to get onto the road its father, the locomotive, found the best. In roadways there is nothing like steel, nor anything that makes any approach to it. Of course in sections too thinly settled to justify two roads (a common road and a light railway) the business automobile will have to use the common road, but wherever it does so it will be compelled to charge a high rate for freight and passengers, on account of the great resistance to progression encountered on all roads but steel.

In the above paragraph reference is made to the flat 12-inch-wide steel rail (plateway rail) recommended by some for country roads and city streets. Its cost is higher and its efficiency lower than other forms of rails for light vehicles, but vehicles without either flanged wheels or guides may run on it. It would be too much of a strain on eyes and nerves of drivers of either autos or horses, especially the latter, to keep on it, except with frequent intervals of rest, and it encroaches upon the horse's path, causing him to slip and fall, for the horse is a poor skater.

But after horses are barred or taxed out of cities, and steel rails laid on all streets for all vehicles to run on, as I think they will be, it will probably be found that, for thronged streets, the plateway will serve better than rails which require the wagons or autos which use them to have either flanged wheels or guides. The plateway will not keep as free from dirt as other rails, but even on a plateway, if nearly level, a man could propel as heavy a load as one horse hauls on a badly paved street. Hence when the majority of residents in any city realize that horses should be barred out, they can answer those horse-users who claim that they are too poor to buy a motor wagon: "We will put down plateways on which a ball-bearing vehicle will almost run itself, and you can yourself propel your wagon on it, and not be worried with a horse, or be compelled to feed or shelter one; at steep places we will have moving ways to carry your wagon up, or moving endless cables to pull it up. It is as natural for man to oppose everything that is good for him as to cry for things that hurt him."

THE DEVELOPMENT AND USE OF THE SMALL ELECTRIC MOTOR.

IV.—APPLICATIONS TO GENERAL MANUFACTURING PURPOSES.

By Fred M. Kimball.

With this article, Mr. Kimball concludes a series which began in our April number and which in its entirety constitutes a comprehensive practical review of the economy of the electric motor, and the principles governing the choice, installation, and operation of motors for power purposes in the machine shop, factory, and industrial and domestic establishments in general. The May and June numbers were especially noteworthy for the definite data they gave as to power requirements of standard metal and wood-working tools. This has an active interest of a different sort in its suggestiveness of the wide range of uses to which the electric motor may be applied.

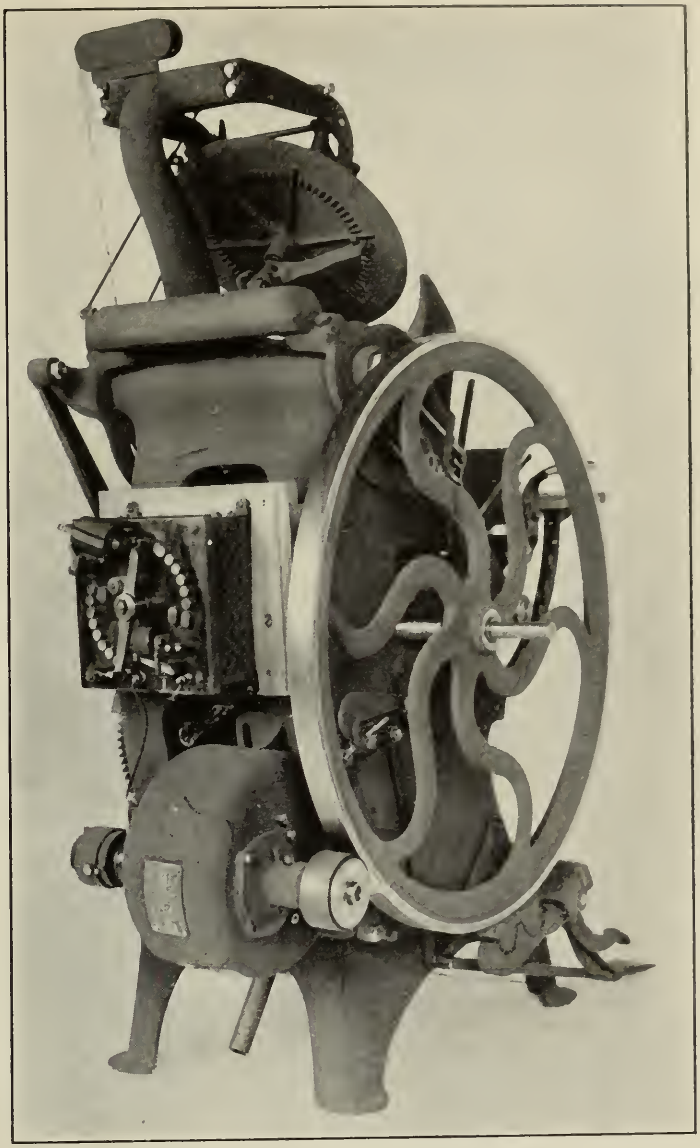
The "General Electric" motors illustrated throughout this article and the preceding papers by Mr. Kimball are those manufactured by the General Electric Co., of Schenectady, N. Y., and in England by the British Thomson-Houston Co., of Rugby.—The Editors.

IF one makes even a cursory survey of the mechanical processes carried on in connection with the varied lines of industry throughout the United States, he cannot but be astonished at the large number of electric motors, of small and medium size, which are employed in nearly every manufacturing business. The problems involved in thus applying motors to the operation of various classes of machinery in various lines of work are exceedingly interesting, and a notable portion of the best talent which the country affords has found full employment in advancing the art, both theoretically and practically, during the past twelve or fifteen years.

The printing trade offers an admirable field for the efforts of the motor salesman and engineer. It was one of the first to be carefully exploited. Presses, stereotyping machinery, folding, binding, embossing, and stitching machines, are all particularly adapted for receiving the electric drive.

The requirements of press operation are such that an electric motor forms an ideal adjunct to almost any variety of press, large or small. The work of a printing press is unavoidably intermittent. If a motor is employed to drive it, then when the press is stopped all expense for power ceases. With any other form of power transmission, friction, condensation, or leakage losses are nearly constant.

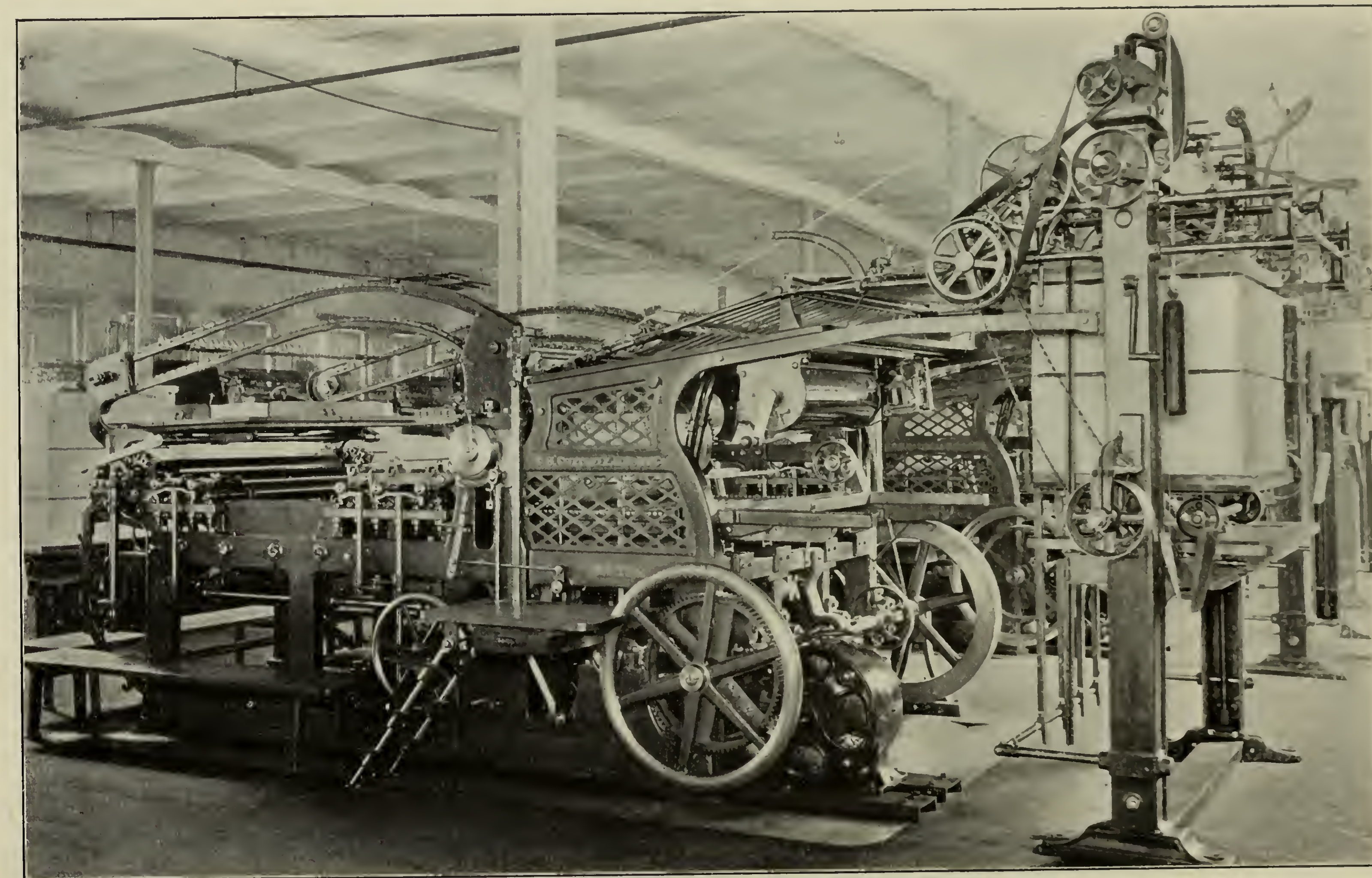
When a line of presses is driven from a countershaft with its attendant overhead belts, etc., not only are the belts much in the way, but they are constantly generating static charges of electricity which in turn cause lint and dirt to adhere to them until the weight of these accumulations overcomes the static effort and then these masses are oftentimes thrown off into the press, where they smutch the work and fill the fine lines of the types or cuts with a substance which is removed with much difficulty, and at the expense of much valuable time. A very large percentage of fine work is spoiled by this dirt and the drip of oil from overhead hangers each year in every shop where the belt drive is used. Again, presses require frequent speed variations to accommodate the different varieties of type, ink, and paper which are used.



GOLDING JOBBER, FRICTION DRIVEN FROM ½-HORSE-POWER GENERAL ELECTRIC MOTOR.

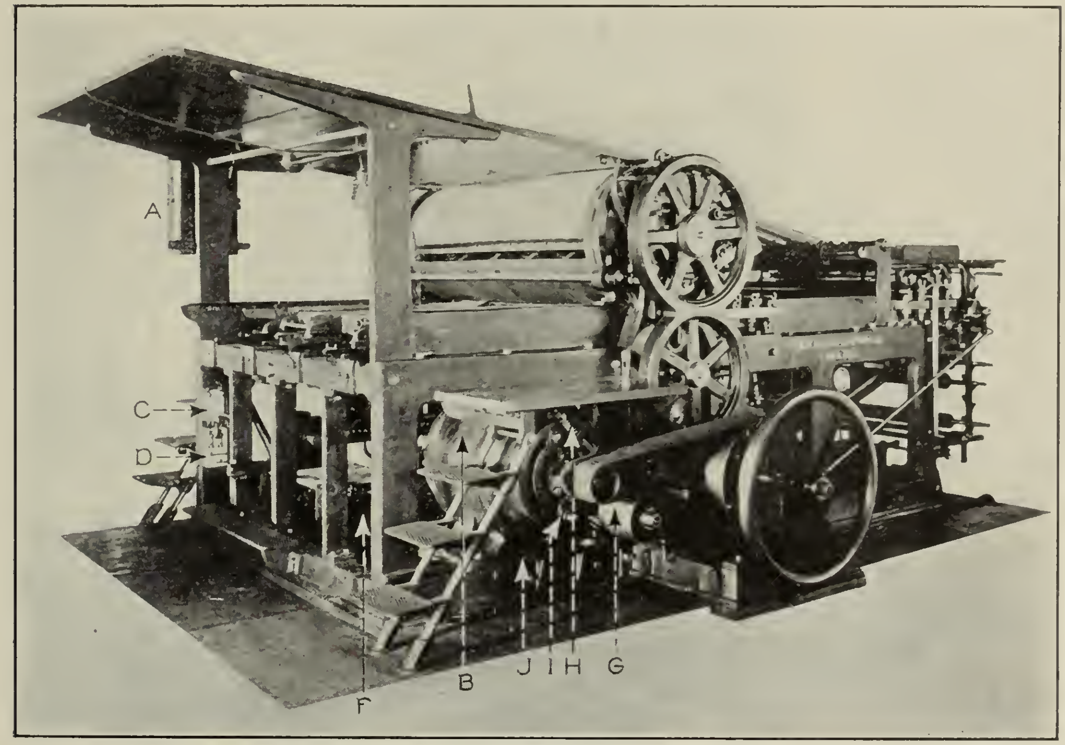
Experience has shown that the substitution of electric motors for other mechanical means of driving printing machinery enables the output to be increased very materially in almost any given case. This is largely due to the wide yet finely graduated range of speed control which it is possible to obtain. In the case of a mechanically driven press operated through the medium of belt-connected cone pulleys, the increase of speed from the lowest to the highest is, usually, about 125 per cent., but this great increase can be made in only about four steps. The same increase may be divided into eight, ten, or even more steps when the electric motor with proper controller is used.

With pulley-and-belt transmission it may readily happen that a certain step is too fast to produce perfect work with safety, while the



GROUP OF PRESSES, ELECTRICALLY DRIVEN BY GENERAL ELECTRIC MOTORS, PLANT OF McCLURE'S MAGAZINE.

next larger driven cone gives a speed much less than might otherwise be used. When the electric drive is employed the speed may be adjusted to a nicety and the highest production of satisfactory work obtained. This possibility of increased production is, in many instances, so great as alone to justify fully the installation of individual motors on all the presses in a printing establishment, even were there no other advantages to be gained.

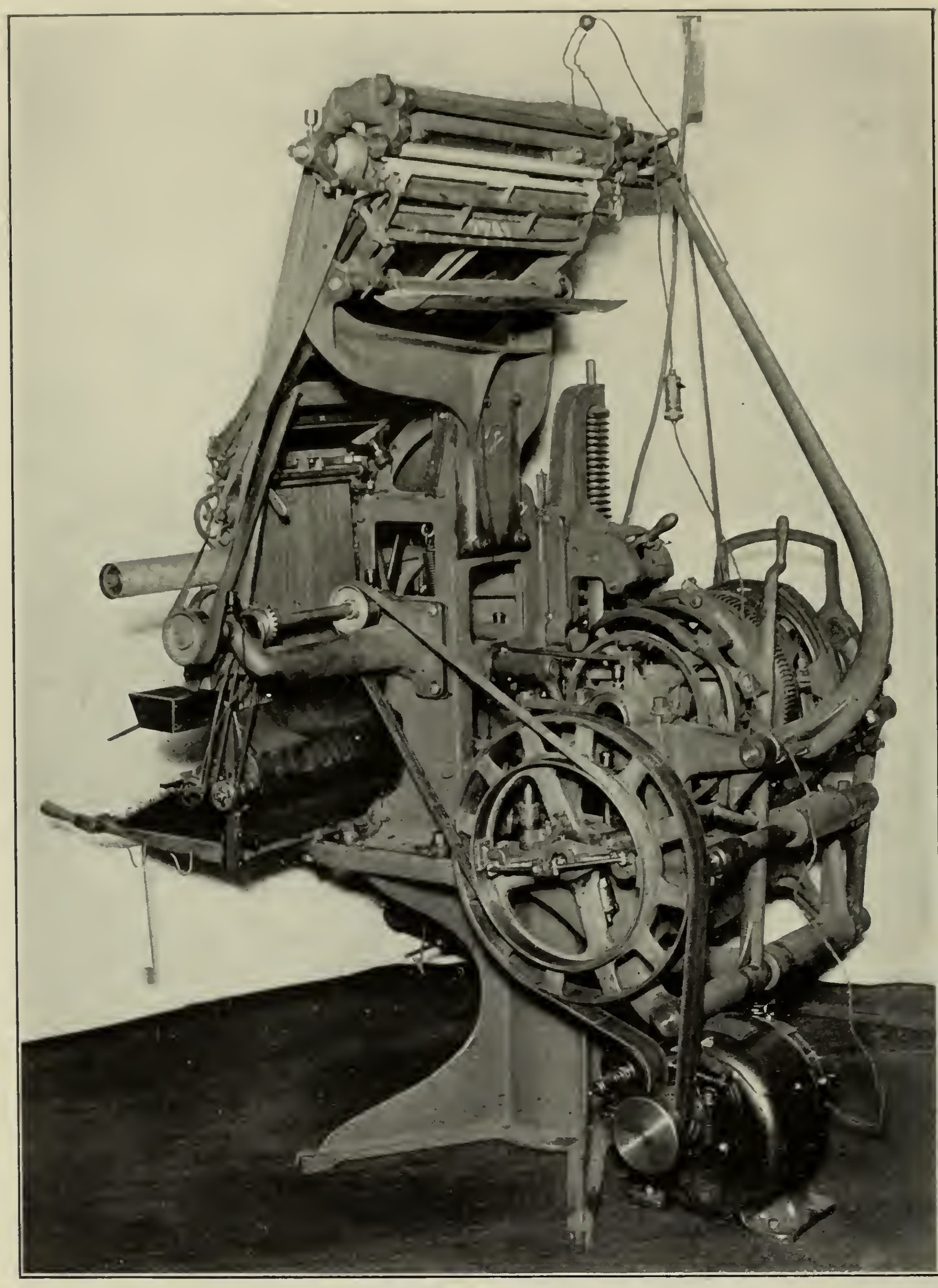


TYPICAL INSTALLATION OF ELECTRIC MOTOR FOR DRIVING A PRINTING PRESS.

A, controller; B, motor; C, main switch; D, fuse block; F, resistance box; G, belt-tightener pulley; H, tension spring governing belt-tightener pulley; I, carriage holding pulley; J, bracket on which motor is mounted.

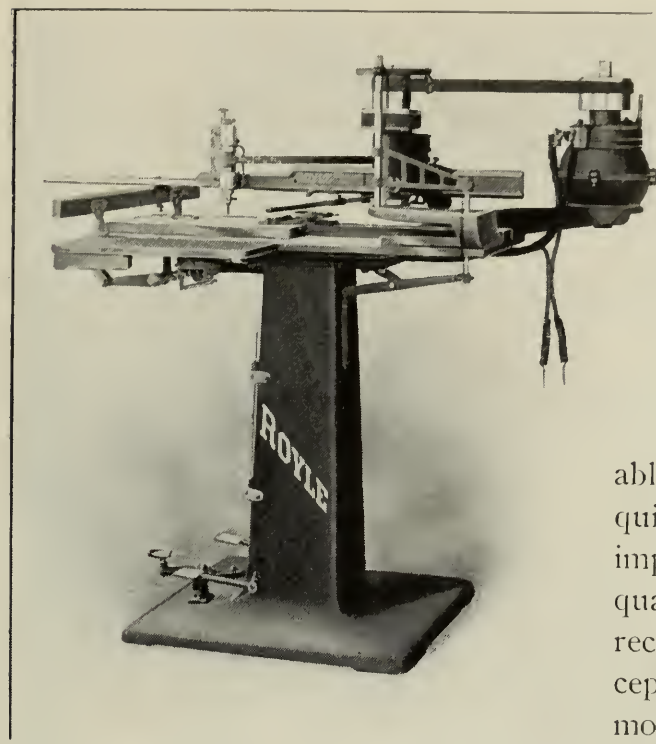
A motor may usually be attached to a press in such a way that there is no belt above the feed board, and moreover it may frequently be set into or under the frame so that it does not take up valuable floor space. Again, the elimination of vertical and overhead belts removes a source of danger, especially when female operatives are employed. Many serious accidents have happened through the dresses of female employees catching in the belts or on the shafts or pulleys and thereby drawing the wearers into the machinery.

Printing presses as well as other machinery, when equipped with motors, may be placed in such location in regard to light, air, and sequence of operations to be performed as to obtain the best possible results. Where the belt drive is relied on the presses must be lined



ELECTRICALLY OPERATED LINOTYPE MACHINE.
Motor made by General Electric Co., Schenectady.

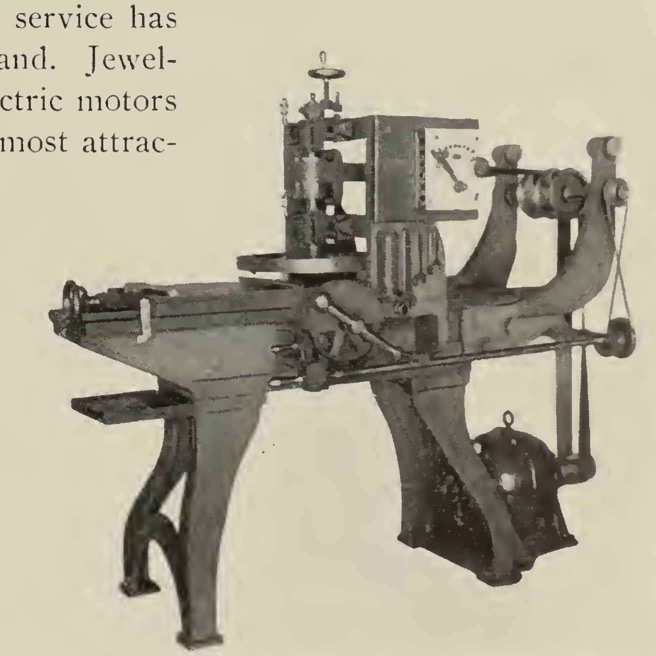
up in reference to the line shafts, and there is little flexibility in location. Everything being considered, elevators may be operated more advantageously by electric motors than by any other means. Especially is this the case when the severe requirements of the modern "sky



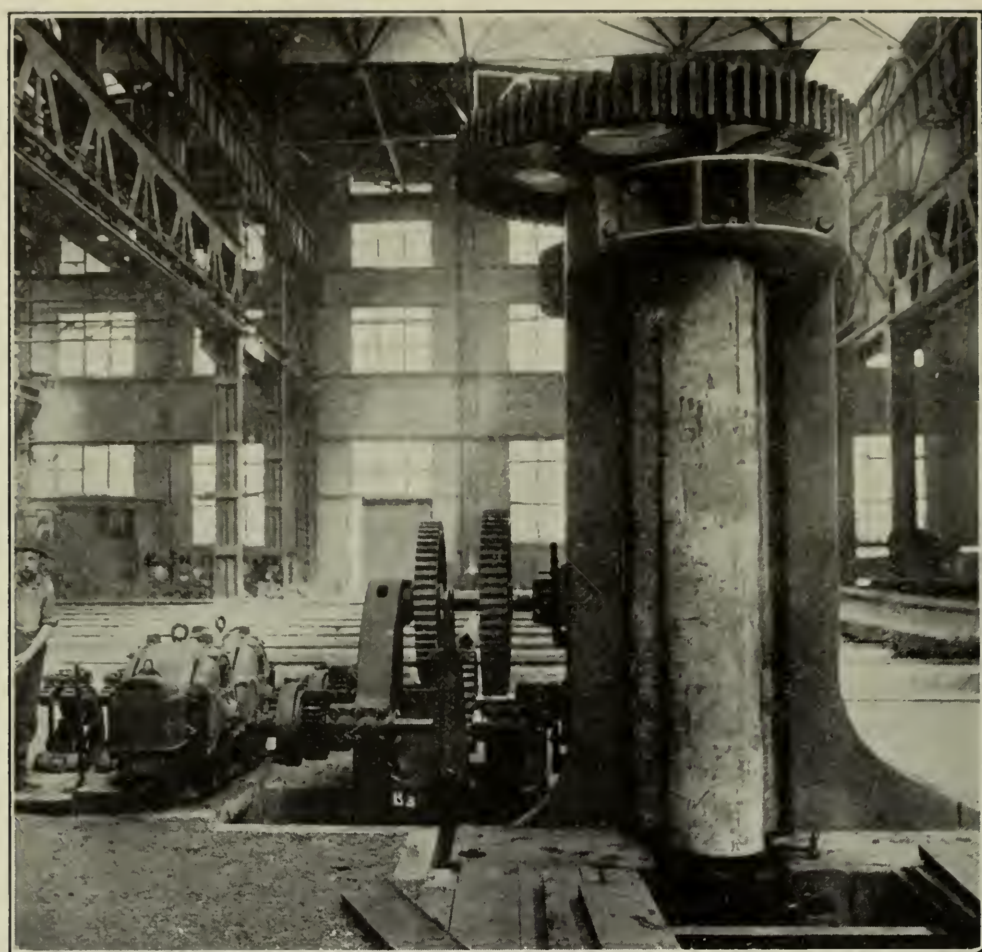
ROYLE ROUTER DRIVEN BY SPRAGUE VERTICAL MOTOR.

scraper" are considered. The tenants in such office buildings, comprising from ten to twenty or more floors, must be afforded rapid transit; and the elevator cars must be under perfect control in stopping and starting and in speed. They must be able to pick up headway very quickly, and it is well-nigh impossible to obtain an equal quality of service in these directions with any system except one employing electric motors. The expense of operating such elevators is also, usually, less than by any other method which will realize equally satisfactory results.

The use of the electric motor enables proprietors of stores and markets to operate coffee grinders, meat choppers, etc., by power where heretofore this laborious service has had to be performed by hand. Jewelers and opticians find electric motors furnish the cleanest and most attractive power supply possible to obtain.


2-HORSE-POWER SPRAGUE MOTOR BELTED TO WESEL DANIEL PLANER.

The electric motor finds a particularly useful application in shipyards and erecting works, in conjunction with various machine tools which may be carried to different portions of the erecting floor or yard, and there the piece to be wrought may be machined in

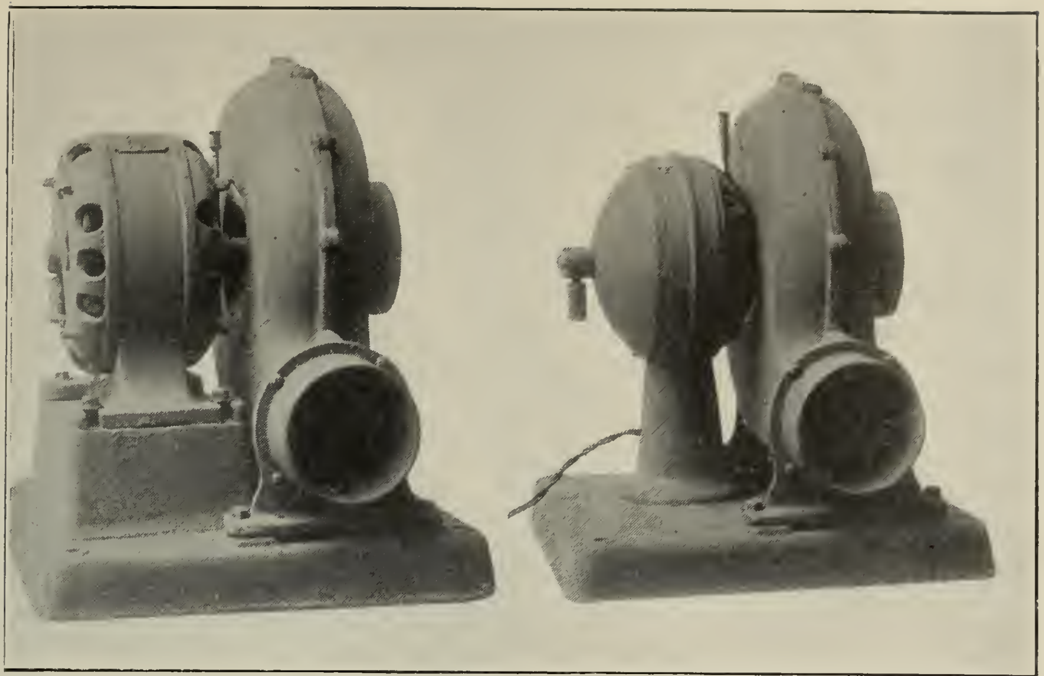


HEAVY VERTICAL STRAIGHTENING OR BENDING ROLLS DRIVEN BY TWO 50-HORSE-POWER WESTINGHOUSE ALTERNATING-CURRENT MOTORS.

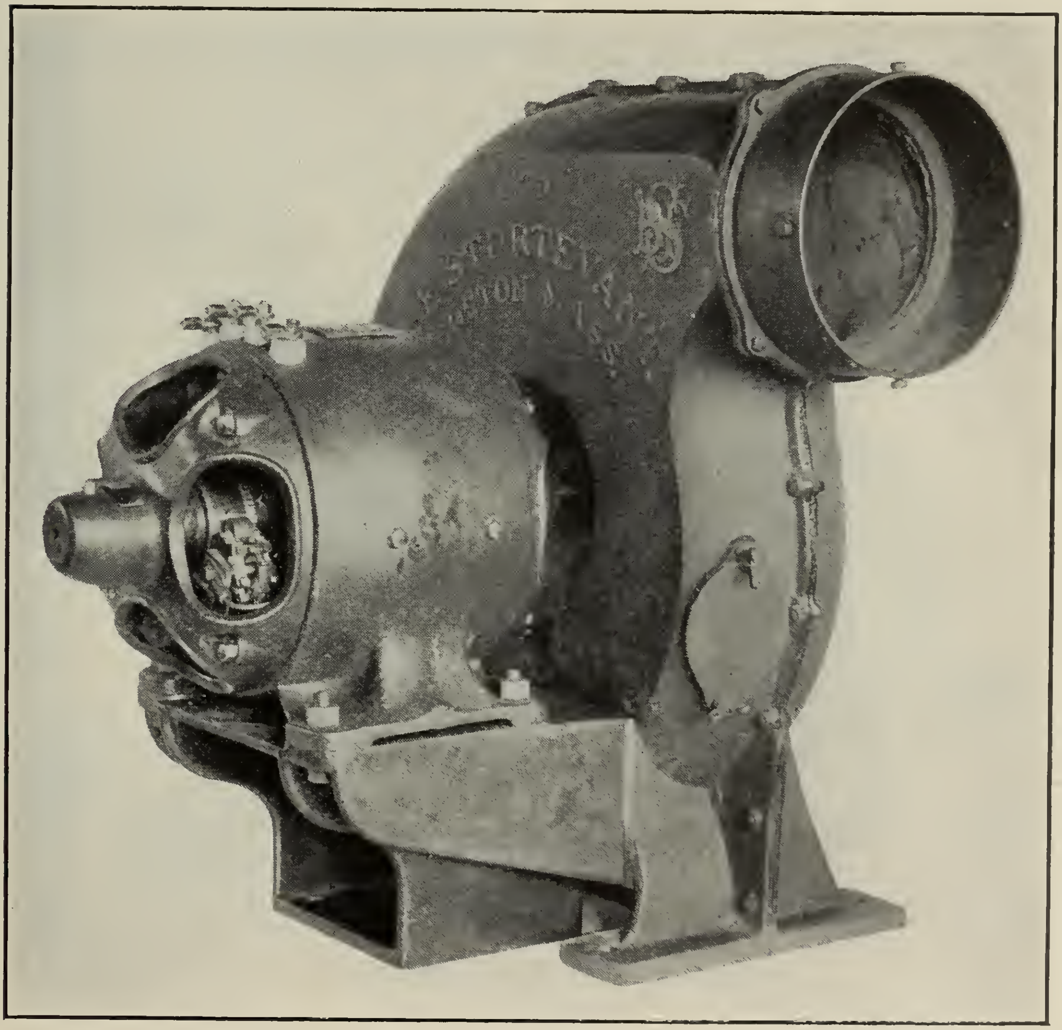
New York Ship-Building Company, Camden, N. J. Tool by Bement, Niles & Co., Phila.

place. This saves a great deal of transportation of heavy material, and the extent to which modern ship and bridge yards are equipped with electric motors is surprising. For operating portable emery grinders, forges, drills, and similar machines, the electric motor is particularly adapted. The large ship-yards at Newcastle-on-Tyne in England employ hundreds of motors, and the larger ship-yards of the United States are not at all behind them in this respect. At the yards of the New York Shipbuilding Co., the Newport News Shipbuilding Co., the Fore River Engine Co.'s works, and elsewhere, motors are very extensively used, for portable tools and for driving machinery in the shops.

On shipboard electric motors displace donkey engines. They are much more compact, dispense with the labor of special engine runners, and are not nearly so liable to break down or to fail at an inopportune time. It is quite safe to say that the larger number of fans and exhausters installed at the present time are equipped with electric



1/15-HORSE-POWER GENERAL ELECTRIC MOTORS DIRECT-CONNECTED TO CANEDY FORGE BLOWERS.

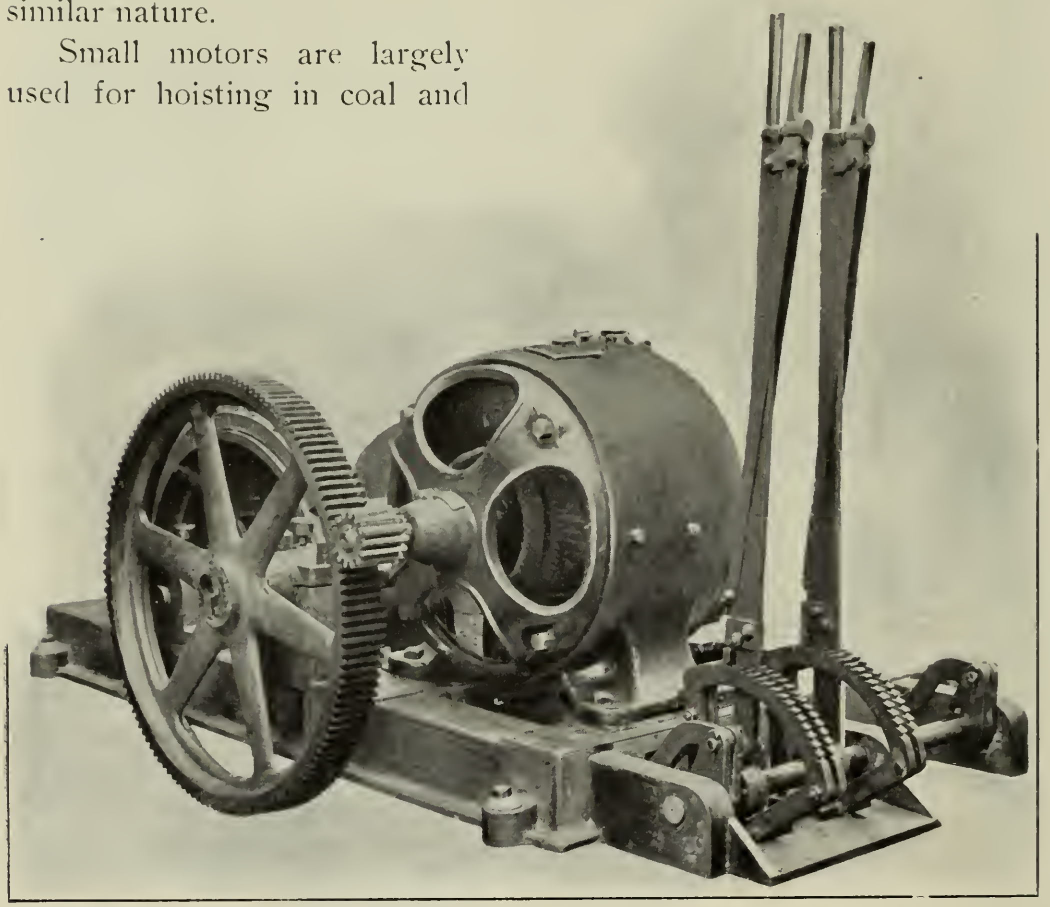


GENERAL ELECTRIC MOTOR DIRECT-CONNECTED TO STURTEVANT BLOWER.

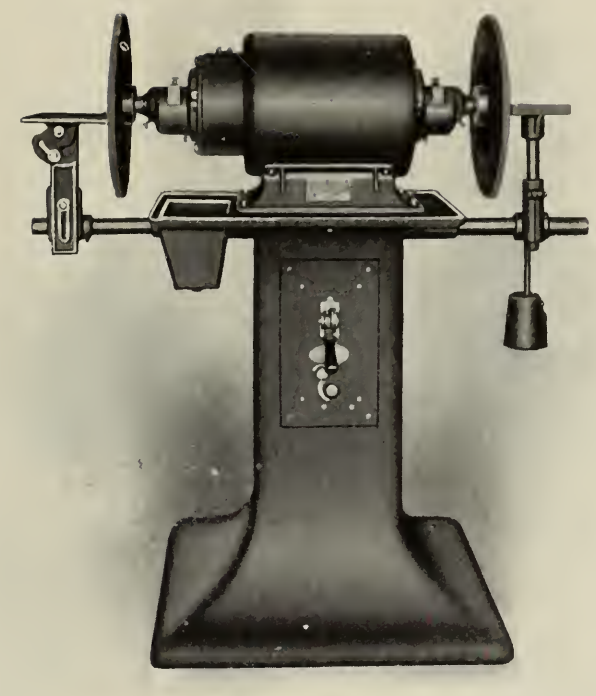
motors. It has recently become possible for a blacksmith to displace his clumsy bellows by a compact little outfit which furnishes blast for his forge while he attends to other duties. The wholesale clothing trade consumes an enormous number of motors in a year. A very large percentage of sewing, button-hole, and other similar machines derive their power through the unobtrusive little machine, which in construction is so simple, and in operation so quiet and reliable.

Bakers and confectioners find no method of supplying power to their mixing, kneading, and stamping machinery so cleanly or desirable as the electric motor. In large hotels, like the Waldorf-Astoria, motors are very extensively used in the kitchen and steward's department for polishing and cleaning silver, chopping and grinding, operating laundry and knife-cleaning machines, ventilating fans, ice-cream freezers, ice crushers, and bread-mixing machines. Motors, with extended shafts on which swabs may be mounted, are also used for cleaning pitchers, syrup jugs, carafes, and other articles of similar nature.

Small motors are largely used for hoisting in coal and



ELECTRICALLY OPERATED PORTABLE HOIST.
Made by Denver Engineering Co.; equipped with motors made by General Electric Co.


DISC GRINDER DRIVEN BY STOREY MOTOR.

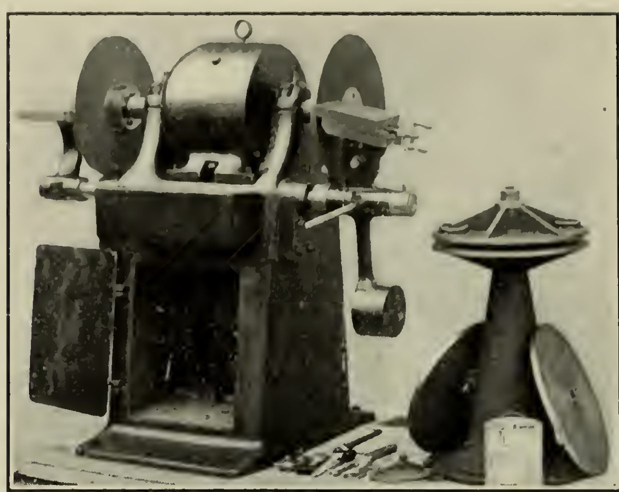
other mines; it is often necessary to sink short shafts from one level to another while exploratory or developmental operations are going on. A self-contained electric hoist, operated by a 1-horse-power motor, may be carried from place to place by two or three men, set up very quickly, and will handle as much material as the number of men working in a small breast can take out. The larger motor-driven hoists for mining operations have been very largely used for several years.

Most of the cash-carrier systems in large retail stores are operated by electric motors. Manufacturing druggists find them of great utility and convenience in operating mechanical filters, lozenge and pill machines, drug grinders and mixers; while one of the latest applications is embodied in an ingenious motor-driven candy puller, which not only does its work in a far more satisfactory and cleanly manner than it can be done by hand, but which—when displayed in a show window—is a source of never-ending interest and attraction to passers-by.

Motor-generator sets are in wide demand, not only for the charging of storage batteries in automobiles and launches, but also for displacing the wasteful, expensive, and troublesome primary batteries of telephone and telegraph systems.

Small motors have recently been used to lighten the work of typewriters. They are so applied to these machines as to do all of the real work of striking the type bars, etc., in response to a light touch on the keys of the key board. Typewriters arranged with these motors are very attractive. Bottlers of aerated and mineral waters find uses for motors to operate their bottle cleaners, wiring machines, sterilizers, and washers. They also employ them for operating pressure pumps, carbonating machines, and similar apparatus.

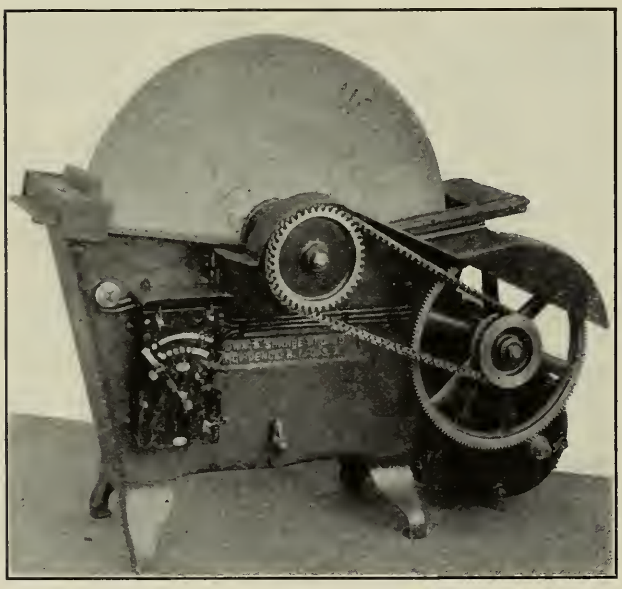
The silk mills in Italy and France use a very large number of



RANSOM 18-INCH UNIVERSAL DISC GRINDER, DRIVEN BY AKRON MULTIPOLAR COMPOUND-WOUND MOTOR.

motors ranging in power from ½- to 1-horse-power for driving their ribbon and other looms. These motors are usually alternating-current machines and have been found most successful. The Susquehannah Silk Mills at Sunbury, Pa., and Marion, Ohio, the Royal Weaving Co. of Pawtucket, R. I., and a few other mills in the United States have been partially equipped with such motors, and their use is growing rapidly. Motors are also largely used in knit-goods factories. Braiders, button machines, knitting machines, and sewing machines are all found to operate more satisfactorily when driven by motors than when operated otherwise.

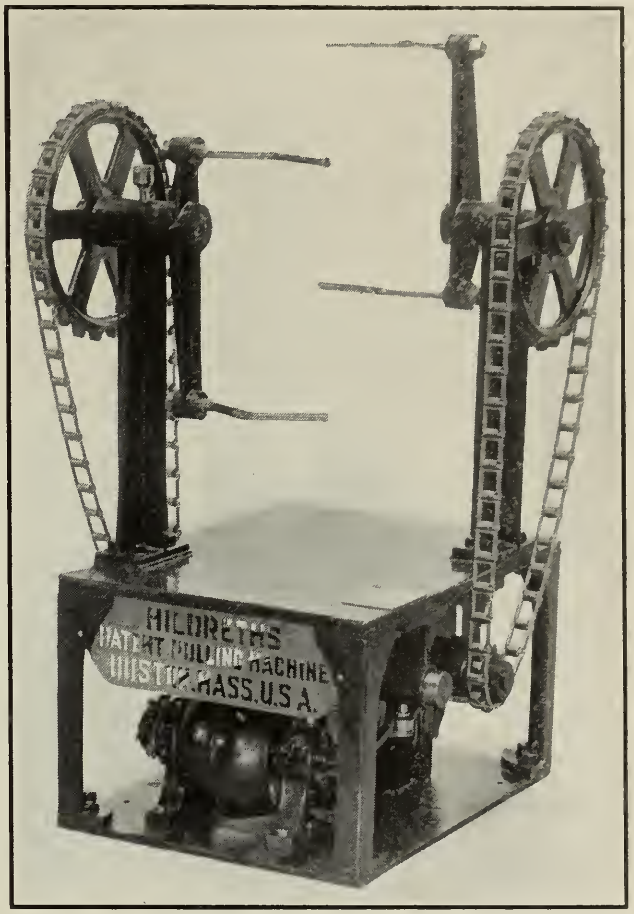
An enormous volume of water is pumped, not only in private houses but in mills, factories, and even in city water works, by electrically operated pumps.



BROWN & SHARPE GRINDSTONE DRIVEN BY BULLOCK MOTOR.

The modern overhead crane, which is such a useful adjunct to machine shops and foundries, would be impossible in its perfection were it not for the electric motor.

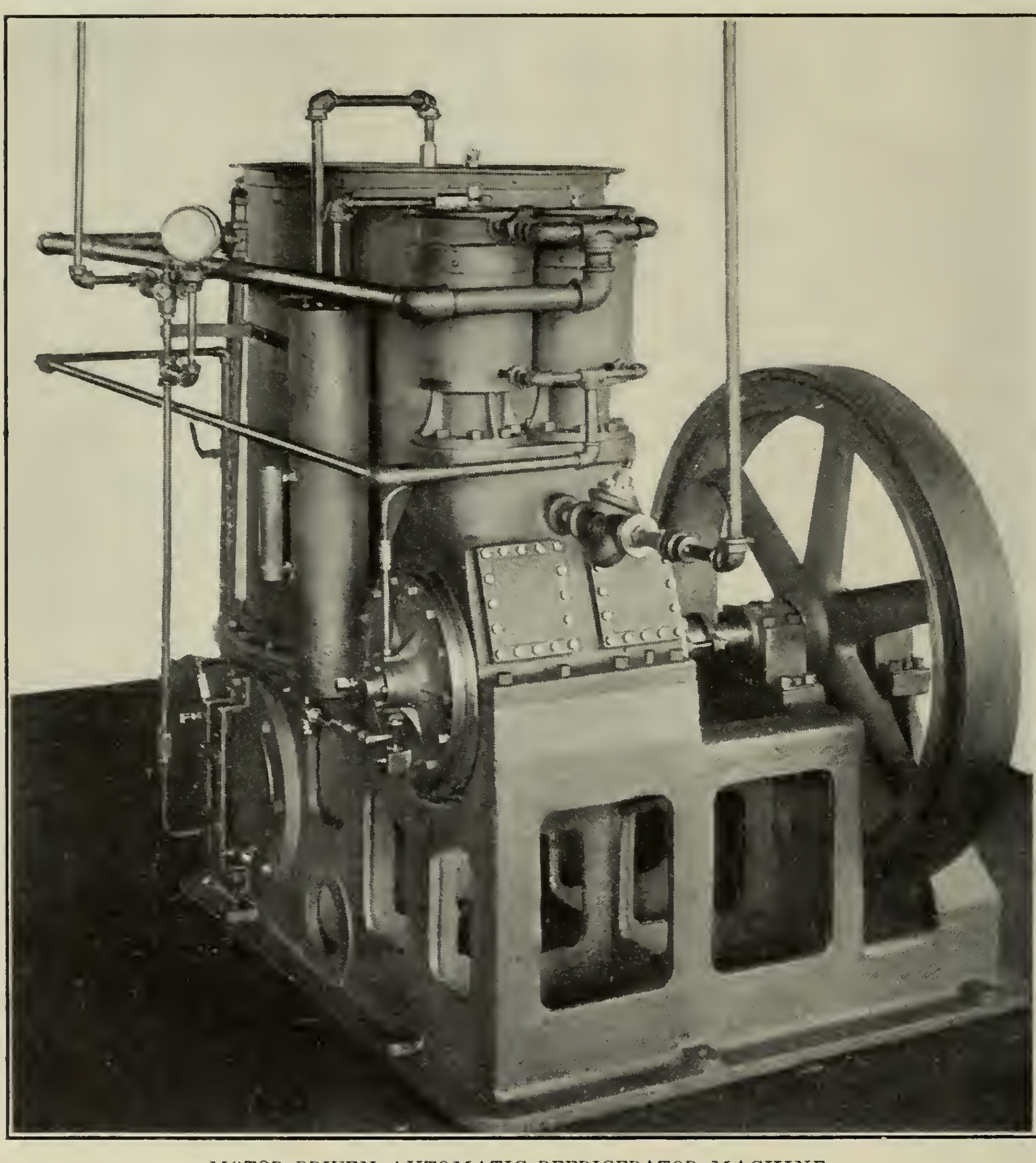
One of the latest applications of motors now being developed is in connection with lumbering in the great forests of the Northwest and elsewhere. Portable saw mills with saws mounted on the extended shaft of motors are used. A portable generating plant which may be relocated from time to time supplies the needed current and, instead of moving the logs to the mill, the mill is moved to the logs and they are sawed into lumber where they fell. The mill is easily moved about through the forest, and the wires leading back to the generators are looped from tree to tree. This method will effect enormous savings, as no waste wood has to be transported, and the smaller and more easily handled neat lumber only is carried out to the railway instead of the huge and unwieldy logs.



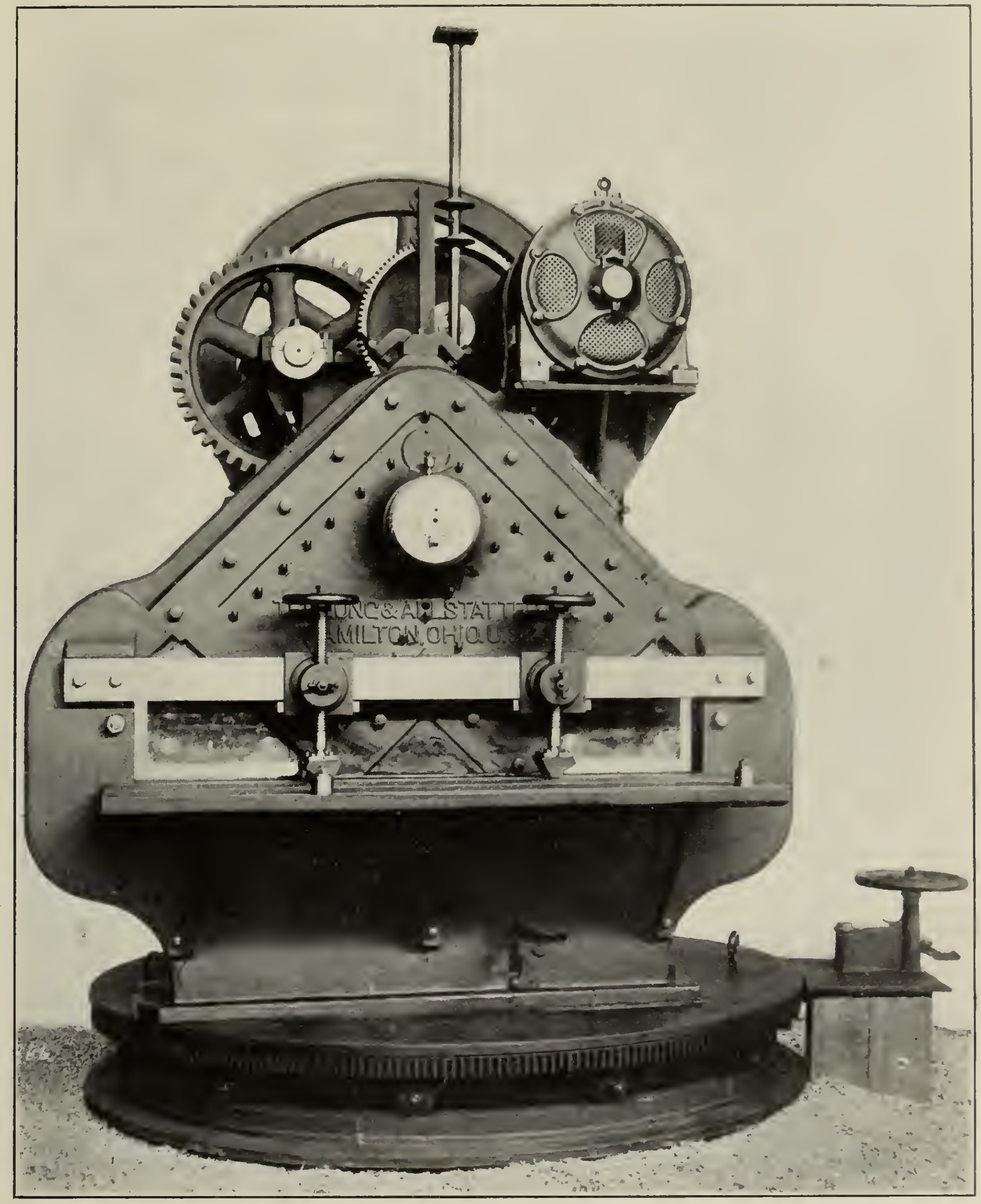
MOTOR-DRIVEN CANDY PULLER.

One of the most attractive uses for small motors is in connection with small refrigerating apparatus. The possibility of installing individual refrigerating and cooling machines in dwellings, dairies, restaurants, cafés, butcher shops, drug stores, etc., has long been appreciated. Many inventors have given their time for years to the attempted solution of the problem involved and much capital has been spent in experimentation. Until the development of the electric motor, a serious handicap was found in supplying power in small units for the operation of these machines. Gas engines, oil engines, small steam engines, water motors, and other prime movers were employed, but in each case the expense of maintenance, attendance, and repairs necessary, and the unreliability of the prime mover, were so great as to prohibit the successful exploitation of the system as a whole. The modern small motor, supplied from the mains of central stations, is admirably adapted for furnishing the power required, and within the last few years a great impetus has been given toward the perfection of refrigerating and cooling machines. It will undoubtedly soon be possible to procure commercial automatic refrigerating apparatus capable of making from 100 pounds to 5,000 pounds of ice in 24 hours, the refrigerating duty of each of these machines being, in general, twice as great as its ice-making capacity.

The apparatus consists, essentially, of a pump for compressing ammonia or sulphur dioxide, a cooling coil for abstracting the heat of compression, a regulator for controlling the admission of the compressed gas to the cooling coils, an expansion coil within the cooling chamber, and a return system of piping to the pump mechanism. The machines require motors ranging from $^1/_6$-horse-power to 5-horse-power, and the operation of the machines is, of course, practically continuous. The regulation of the degree of refrigeration produced has, aside from the question of power, been the most serious one that



MOTOR-DRIVEN AUTOMATIC REFRIGERATOR MACHINE.

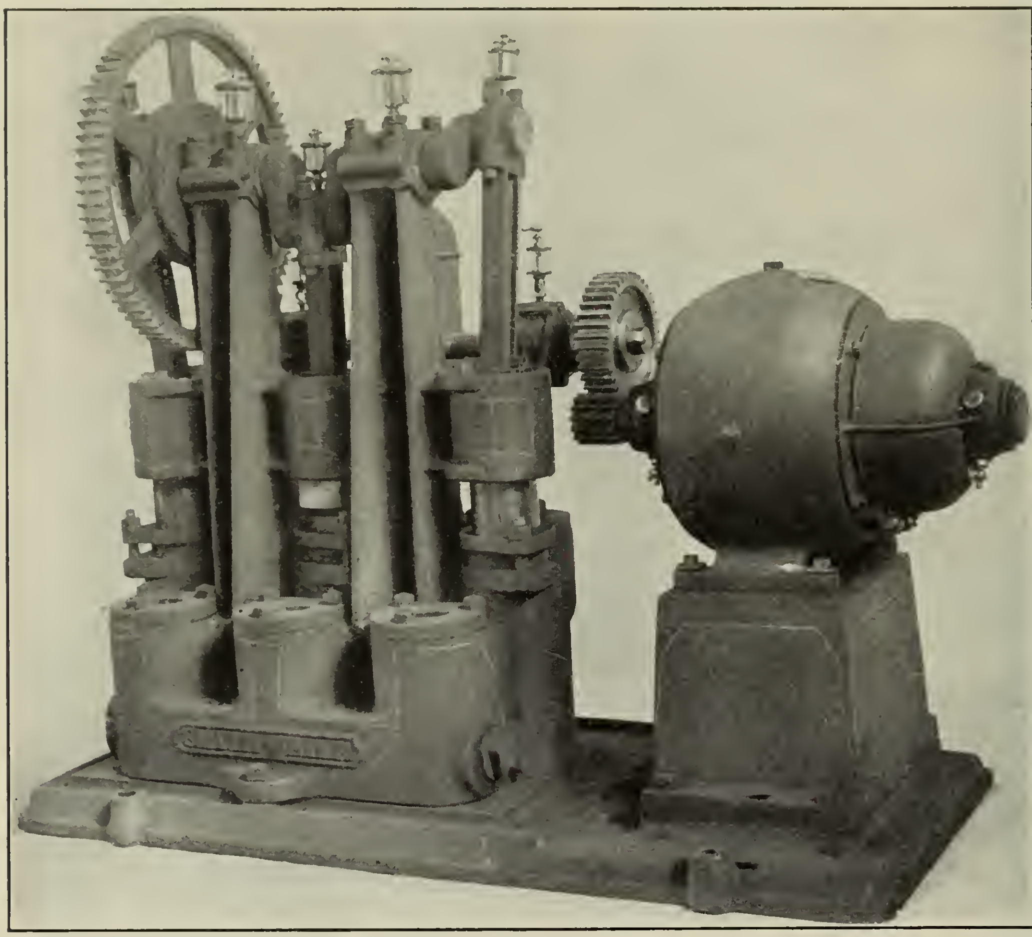


ELECTRIC-DRIVEN ANGLE SHEARS.
Long & Alstatter Co., Hamilton, Ohio; Westinghouse alternating-current motor.

inventors have had to face; it is comparatively easy to effect regulation when any specific duty is to be continuously performed by such a machine, but when the demands are variable, or when a machine is called on to make ice and reduce the temperature in a cold room, and perhaps to supply cooling coils for an air system at the same time, the question of regulation becomes a most serious one.

Within the past two years great progress has been made in methods of regulation, however, and by means of ingenious electrical mechanism, the circulation in the various coils can be controlled to a nicety. As these machines can be built for a moderate price, we may expect to see a very large sale for them in the near future and this will still further extend the field for the sale of motors.

The cost of refrigeration under this system is not prohibitive even when electricity is supplied from coal-burning stations. In a certain installation which was visited recently, it was found that a machine of 1-ton nominal capacity, operated by a motor of 3-horse-power nominal rating, was furnishing refrigeration for a storage room 25 feet by 15½ feet by 8 feet, and a delivery chest 20 feet by 1 foot 8 inches by 6 feet, at an expense (as given by the owner) of $1.00 per day—the average temperature obtained being 42 degrees. Of this one dollar, 56 cents was expended for electricity and 44 cents for water. The current

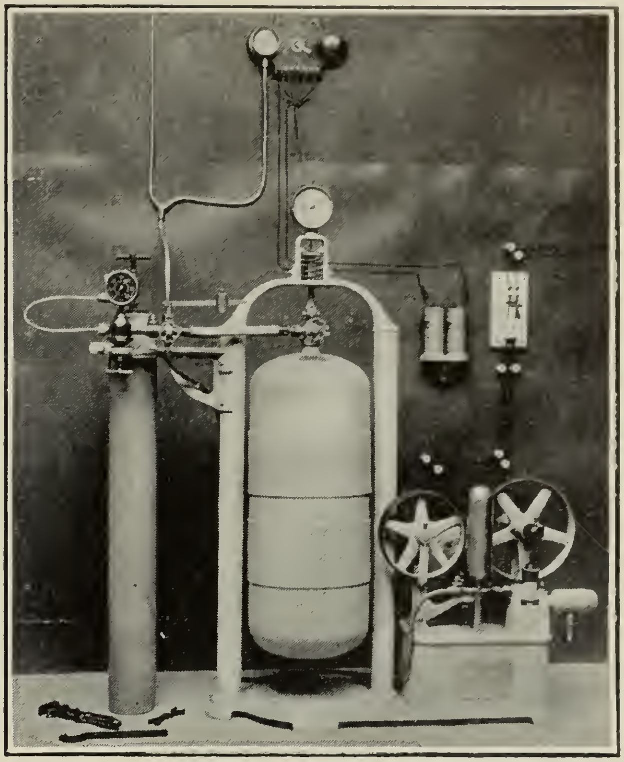


ENCLOSED DIRECT-CURRENT MOTOR GEARED TO TRIPLEX PUMP.

Northern Electrical Mfg. Company's 5-horse-power motor. Smith-Vaile pump.

was supplied by meter at 3 cents per kilowatt and the water by meter at 12 cents per thousand gallons.

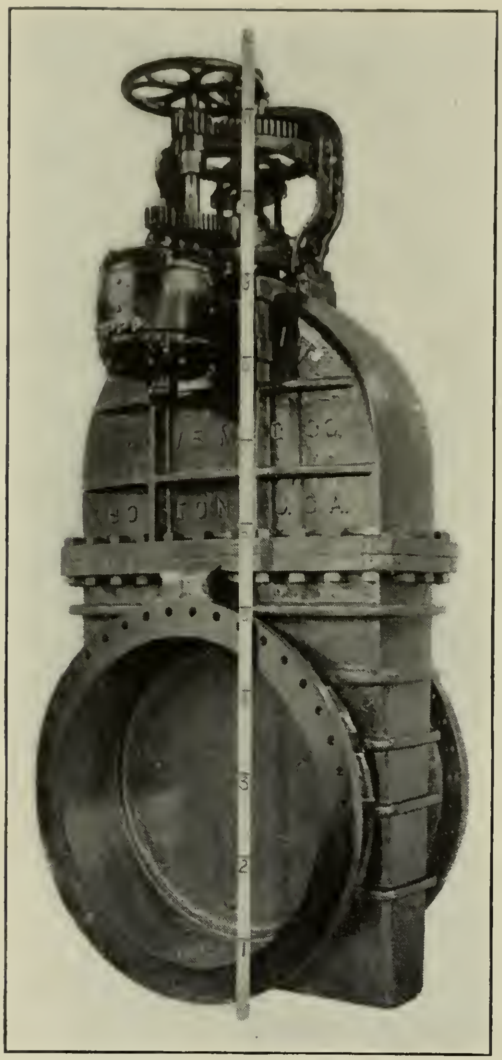
The proprietor of the plant was most enthusiastic in favor of the service obtained; the entire outfit cost him less than $1,000; repairs for eighteen months had been less than $5.00, and the saving over the use of ice had averaged $12 a week. He had been buying ice at what he considered a very favorable figure, viz., $3.00 a ton. In recommending the apparatus, he made a particular point of the freedom from interference with his customers by the iceman bringing in large quantities of ice every morning, and also freedom from the annoyance or drip, dirt, and sloppy floors. It will be observed that his saving of $12 a week would more than pay for the entire installation in two years. In the southern States and in tropical countries, where ice costs from $12 to $25 a ton, artificial refrigeration, on a small scale, even with electricity at 8 and 10 cents per kilowatt, is entirely practicable.



½-HORSE-POWER MOTOR DRIVING CARBONATING APPARATUS.
Lippincott Co., Philadelphia.

Before leaving this subject, we may touch briefly on the application of motors to the manufacture and dispensing of temperance beverages; in other words, let us see what a valuable adjunct the electric motor has become to the modern soda fountain. Formerly, the aerated water necessary for use in soda fountains was prepared at some point where heavy compressors and other machines were available, and this aerated water, under a pressure of several atmospheres, was distributed at frequent intervals to every soda fountain in the well-known, blue-painted, steel tanks, or the more expensive copper ones. In the outlying districts, the express charges on these tanks of water were very considerable, and if the supply did not come promptly to hand, much annoyance was experienced.

Recently, ingenious machines known as "carbonators" have been devised which enable each owner of a soda fountain to produce a supply of carbonated water on the premises, as used. These carbona-



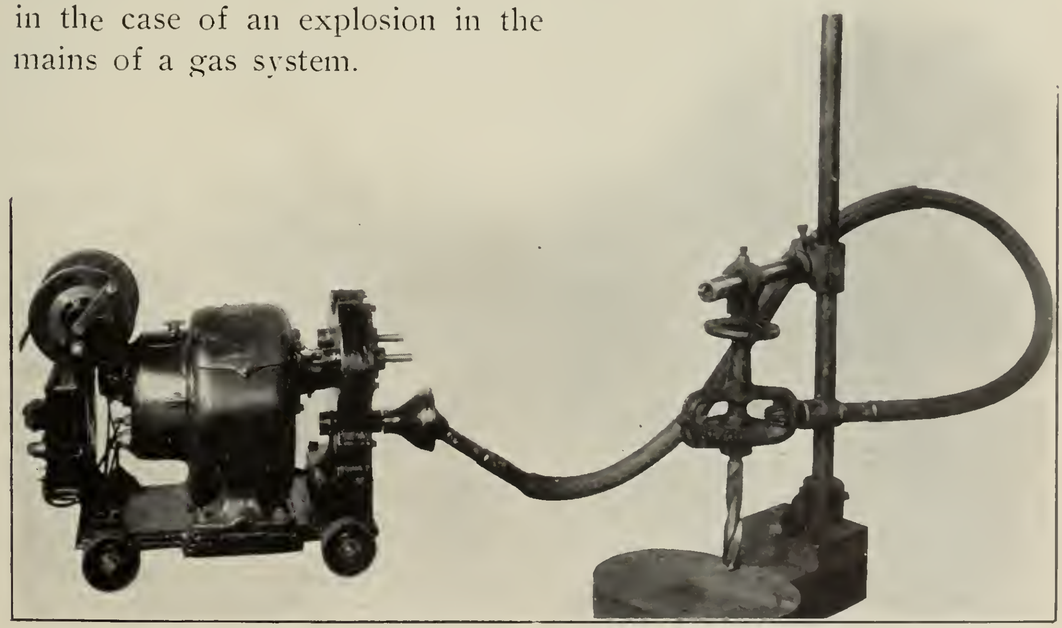
3-HORSE-POWER SLOW-SPEED MOTOR OPERATING 50-INCH CHAPMAN STEAM VALVE.

tors are almost universally driven by electric motors. The carbonating apparatus is simple, automatic, and costs very little to operate. A druggist or confectioner, therefore, who can obtain an electric-current supply, may now provide himself with the apparatus for producing his aerated water and a refrigerating machine for keeping his fountain cold, both pieces of apparatus being driven by small electric motors, under perfect control. With such an installation he is entirely freed from dependence on the manufacturers of aerated water, the transportation companies, and the ice companies.

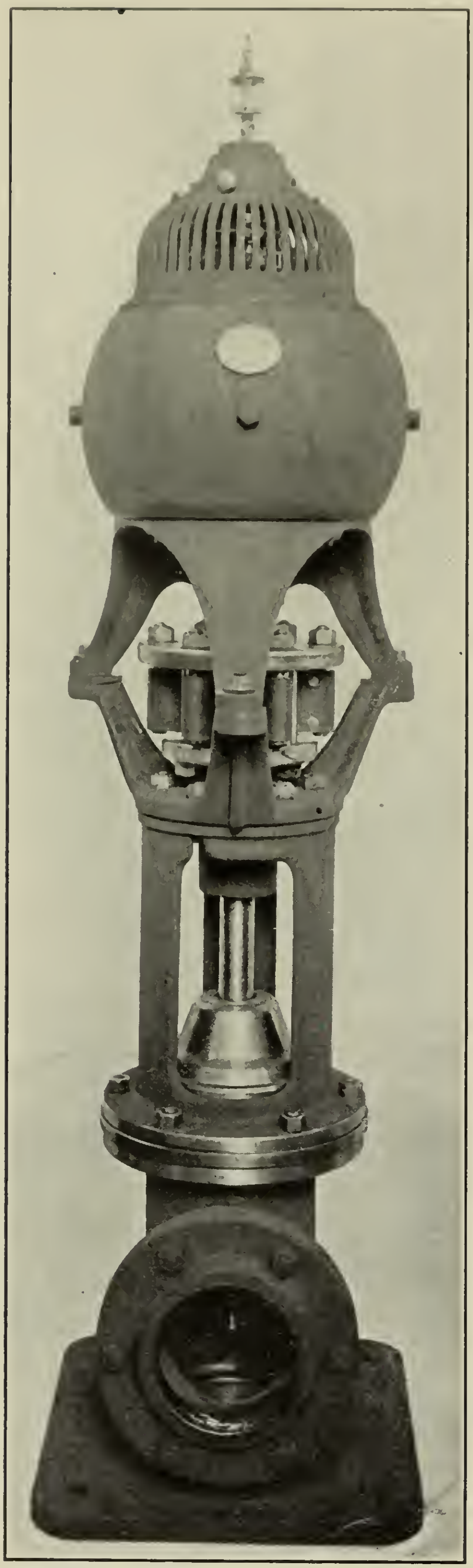
Hospitals, also, find refrigerating machines of the utmost utility in connection with modern therapeutic and surgical practice. On the whole, it seems as though there was no other single unexploited field which offers greater opportunities for the sale of motors and current than in connection with small cooling and freezing machinery.

The problem in operating steam, exhaust, and water valves in large central stations and in connection with gas and water-supply systems has always been a difficult one. It is extremely desirable to be able to control large valves from a distance. In electric light and power stations the control of certain valves from the main switchboard is of prime importance. In the distribution of water and gas the control of section valves from a distance is equally desirable. Systems of rope and wire transmission have been employed with but indifferent results. The same is true of air and hydraulic control. A valve properly equipped with a suitable electric motor, however, enables the problem to be solved readily. By the use of such valves as those figured in the illustrations, complete control of the movement of the fluids circulating through pipe lines may be readily obtained from one or more distant points. A 50-inch valve will in general require the efforts of five or six men twenty minutes to open or close it, whereas with an electric motor the same work may be done in three minutes or less. In cases of explosion or break-down in power stations the escaping steam often fills the building so that section or other valves cannot be approached by the employes in an endeavor to shut or open them; consequently, the whole station apparatus comes to a standstill and nothing can be done until the building is free from steam. If electrically operated valves are used and the control is arranged at two or more stations, the valves may often be manipulated, even while the building is full of steam, so as to enable a portion of the machinery, at least, to be kept in operation. This very valuable feature is becoming more and more prominent as stations are increased in size and output.

Again, the use of electrically operated valves in gas or pipe distributing lines would often prevent immense damage. In the winter, for instance, if a large water pipe bursts in the night, it may take considerable time to get the men out to shut the section valves; the ground may be frozen and the valves almost inaccessible. If such important valves were controlled from the water company's office, immediately notice of trouble was received, the section gates could be closed without disturbing anyone and further damage stopped. The same is true in the case of an explosion in the mains of a gas system.



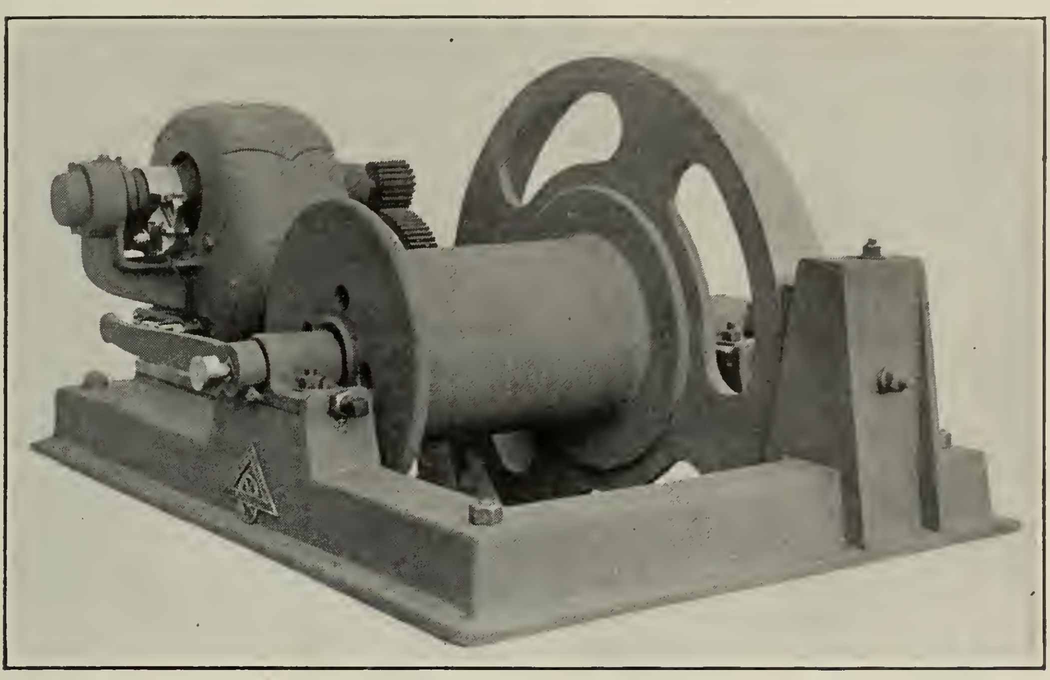
1-HORSE-POWER GENERAL ELECTRIC MOTOR DRIVING PORTABLE DRILL THROUGH FLEXIBLE SHAFT, MADE BY STOW FLEXIBLE SHAFT CO., OF PHILADELPHIA.



NORTHERN VERTICAL 5-HORSE-POWER MOTOR OPERATING WOOD PROPELLER PUMP.

Makers of domestic laundry machinery have lately become interested in the use of motors, and it is now possible to equip a moderate sized house with washing machine and mangle at comparatively small expense. In England, and on the Continent, mangles are very largely used, but they are not much known in the United States outside of hotels. For all plain ironing, such as sheets, pillow cases, towels, etc., in the household, they do very satisfactory work. Ironing, as ordinarily carried on in New England at least, is a very laborious task. By means of a mangle driven by a small motor, however, a large part of the family ironing may be done in a very short time and in a very acceptable manner. A washing machine may be operated by the same motor and, so far as what are ordinarily known as "plain clothes" are concerned, its operation is very satisfactory.

A field which has recently been exploited with much success, particularly in the western States, is that of furnishing motor-driven electric hoists for the use of building contractors. Owing to strikes, many building operations have been tied up; the contractors looked about to see what means they might adopt for overcoming the losses, annoyances, and delays incident to having their hoists and engines out of commission; the electrical people were very glad to assist, and the result has been that some contractors are now using electrically operated hoists, electrically operated pumps, and will undoubtedly also use conveyors and loaders for bringing the material excavated from cellars up to the teams at the street level. No license is needed to enable a man to operate such a machine and this line of business is capable of vast expansion. The success attending the use of motors for hoisting, pumping, and conveying has led other more

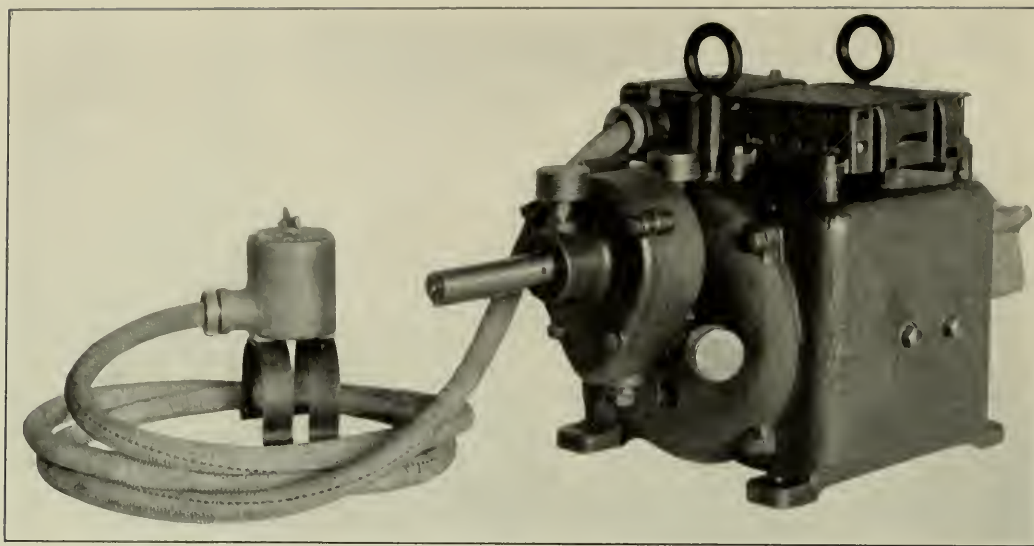


MOTOR-DRIVEN HOIST.
Denver Engineering Co. and General Electric Co.

progressive contractors to install electrically operated saws and similar machines in large buildings under construction, where there is a good deal of wood work to be done; a great deal of time may thus be saved in sawing sheathing and other finish to definite lengths, cutting mitres, etc. Electrically operated pipe-cutting and threading machines may also be used to excellent advantage in similar cases. There appears to be a wide field for central stations to exploit this class of current supply with profitable results.

Building contractors are also beginning to displace by motor-driven machines the slow and laborious hand process of grinding and polishing mosaic floors. Machines which look something like lawn mowers are built in Oakland, California, and in Philadelphia, Pa., for planing and surfacing hard-wood floors. They are said to be eminently successful in operation.

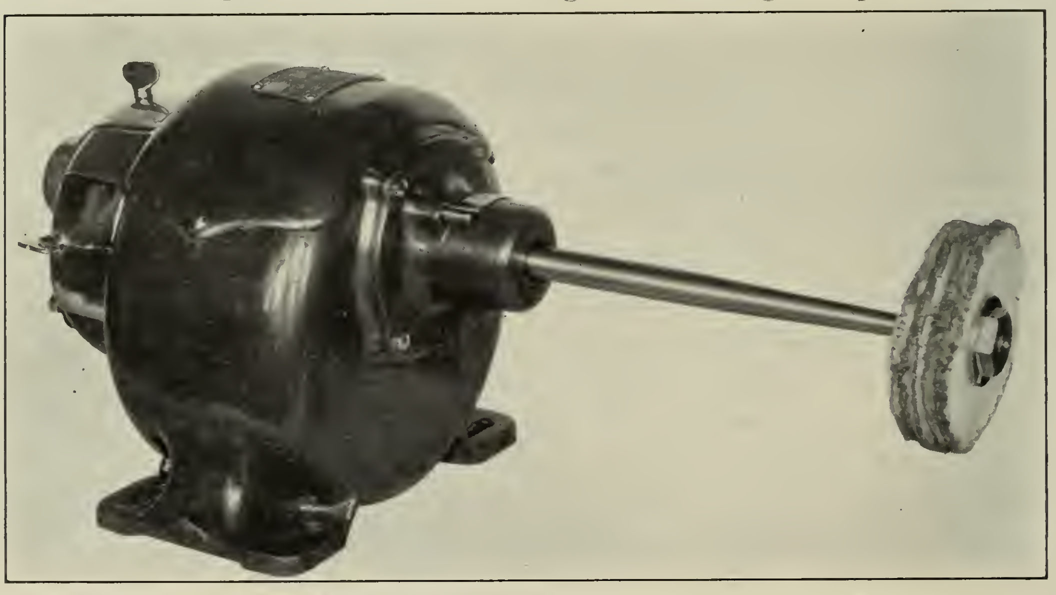
Pneumatic drills for use in mining operations are, in many localities, being displaced by motor-driven mechanical drills. The expense



MINING DRILL OPERATED BY CONTINUOUS-CURRENT MOTOR.
General Electric Co.

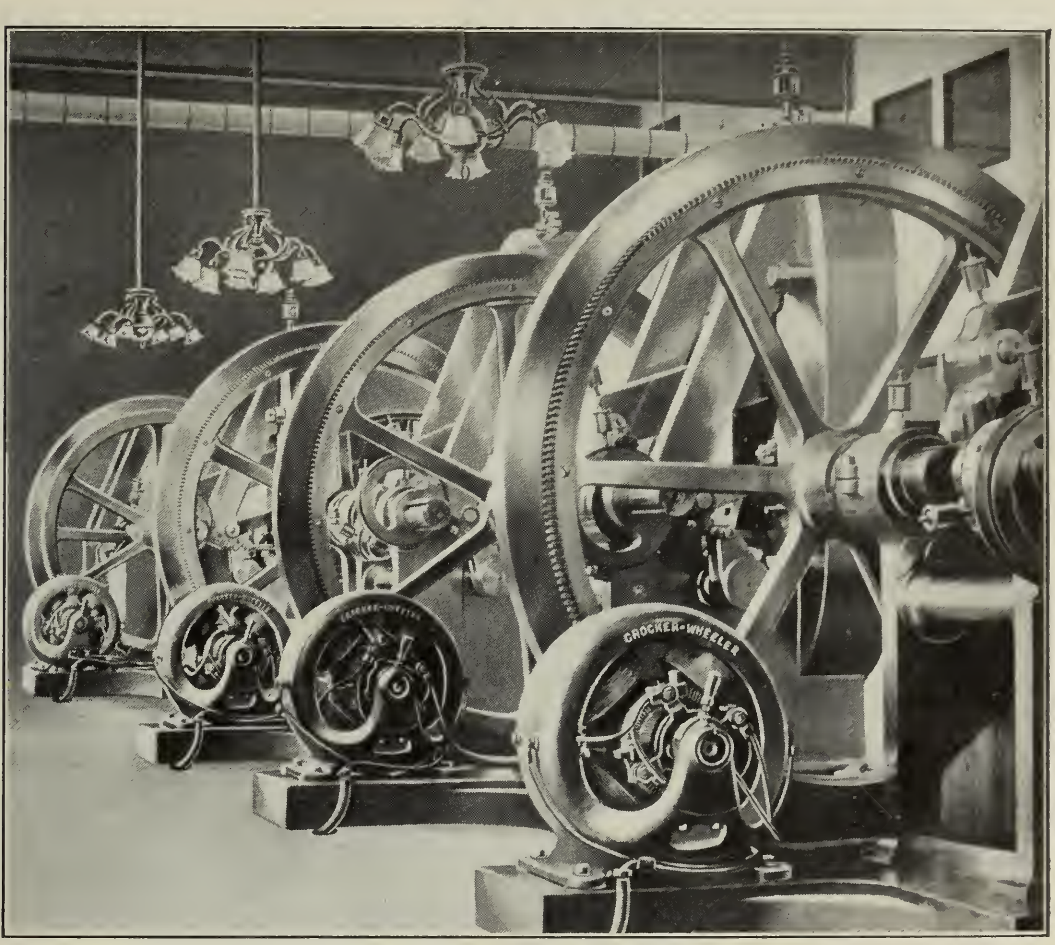
of operation is said to be very much less than that of the air drills and, were it not for the fact that, in many mines, the supply of fresh air which comes from the drill exhaust is absolutely necessary for ventilation, the electric drill would undoubtedly distance its older competitor.

It is of the utmost importance to users of electric motors that the machines purchased be not only of high efficiency, in order to insure minimum charge for the current used to operate them, but of the proper size and winding to perform the work in hand. While it is always well to purchase a motor having a small margin of power above



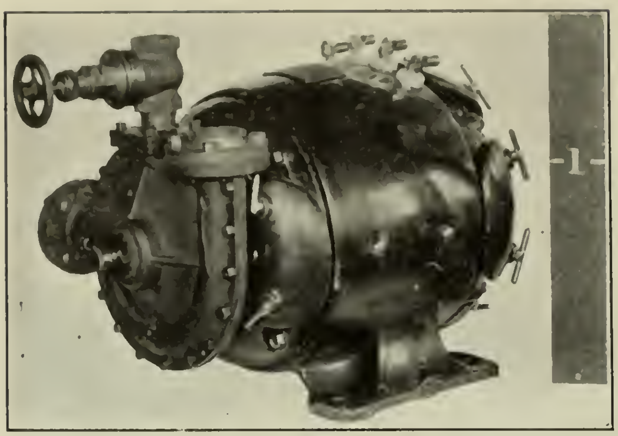
MOTOR-DRIVEN BUFFING MACHINE.
General Electric Co., Schenectady.

the actual requirements, it is not desirable to buy one much larger than is needed unless additional load is to be taken on in the near future. The best motors are so designed that they possess maximum efficiency for continuous operation at their normal rated output, and it should be the aim of the purchaser so to subdivide the grouping of his machinery that the motors in use may be as far as possible operated at their maximum output when running at all.



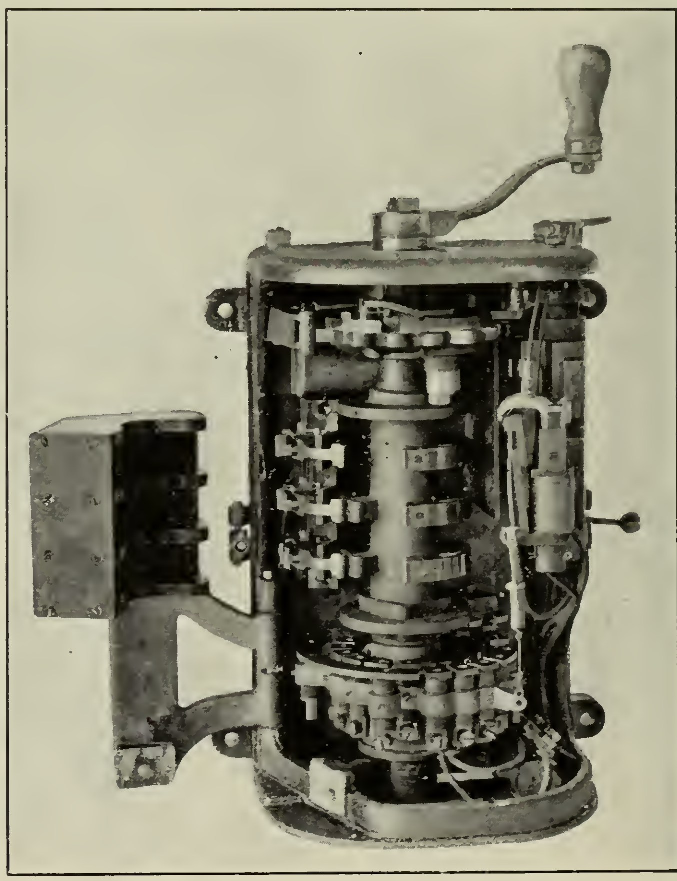
GROUP OF COINING PRESSES IN THE UNITED STATES MINT, DRIVEN BY $7\frac{1}{2}$-HORSE-POWER CROCKER-WHEELER MOTORS.

In equipping a factory a number of machines will often be found which are used only intermittently. As a rule it is not desirable to drive such machines from motors that are operating machinery continuously, for, if this be done, then during certain periods—when the intermittently used machines are idle—the motors will be running at partial load only and at a point much below their best efficiency; and during a portion only of the time, when the machines intermittently used are at work, will the motors be carrying their full load and doing their work in the most economical manner. In cases where a mixed



CENTRIFUGAL PUMP DRIVEN BY GENERAL ELECTRIC MOTOR.

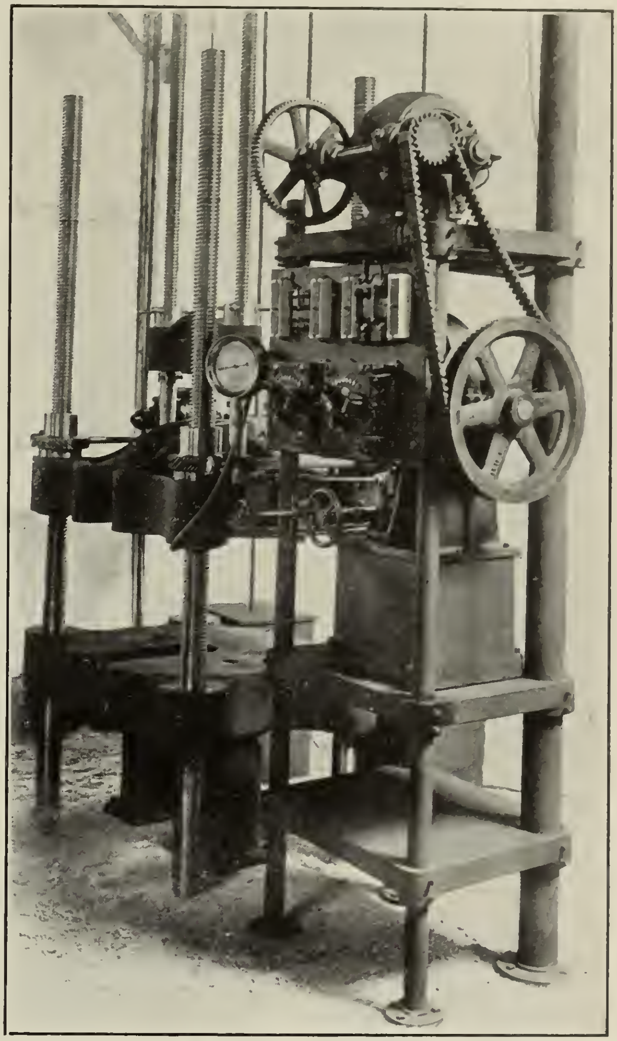
load must be carried, it is desirable to split the drive, so far as possible, and use two or more motors—one for driving the continuously operated machines and the other for driving those which are intermittently used. In this way each motor may be worked at its best efficiency when it is working at all, and a large saving in current bills will result. It will often be found desirable and financially profitable, everything considered, to equip intermittently operated machines with individual motors, and this is especially true if variable speed is required. A failure to exercise due care in selecting the type of motor for the work in hand has often resulted in the inability of the purchaser to obtain that satisfaction from an electrical drive which may always be obtained when proper motors are chosen.



CONTROLLER FOR VARIABLE-SPEED MOTORS.

General Electric Co.

It is a comparatively easy matter to show what the financial aspect of small saving in motor efficiency is, and for those who are unfamiliar with the method of working out a comparison the following illustrations are given: a 5-horse-power motor operated at three-quarters load with an efficiency of 84 per cent., when compared with another motor operated at three-quarters load with 79 per cent. efficiency, shows a very considerable saving. Assuming that these motors are in operation 3,120 hours per year and that the charge for current is 6 cents per kilowatt, we find that there would be a saving in favor of the higher efficiency motor of $39.50 per year. This result is arrived at as follows:

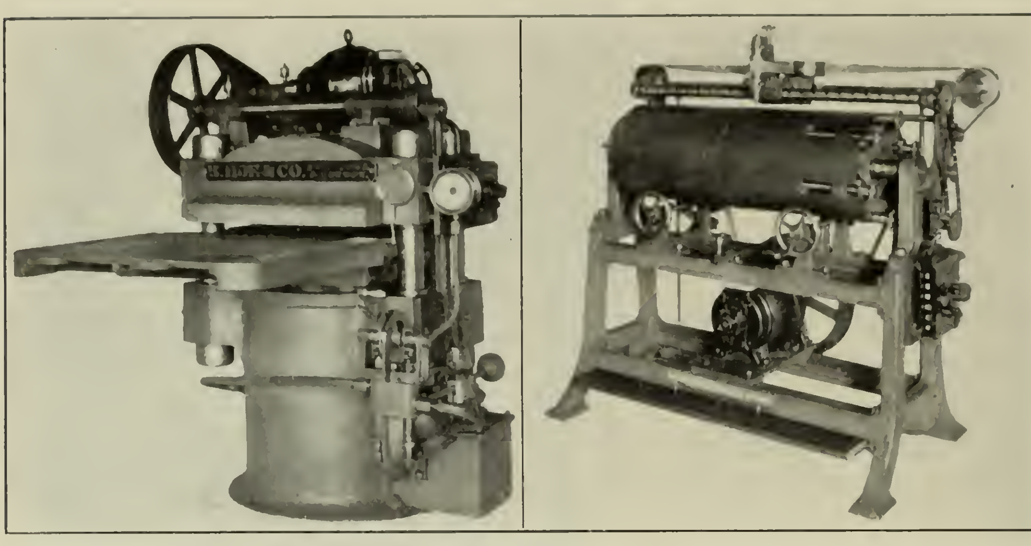


HYDRAULIC ARMATURE PRESS ACTUATED BY ELECTRIC MOTOR.

The 3-horse-power Northern motor at the top drives the pump (concealed by the switch panel) through Renold silent chain. The motor just seen over the upper head at the left accomplishes the travel of the head, saving much blocking of work.

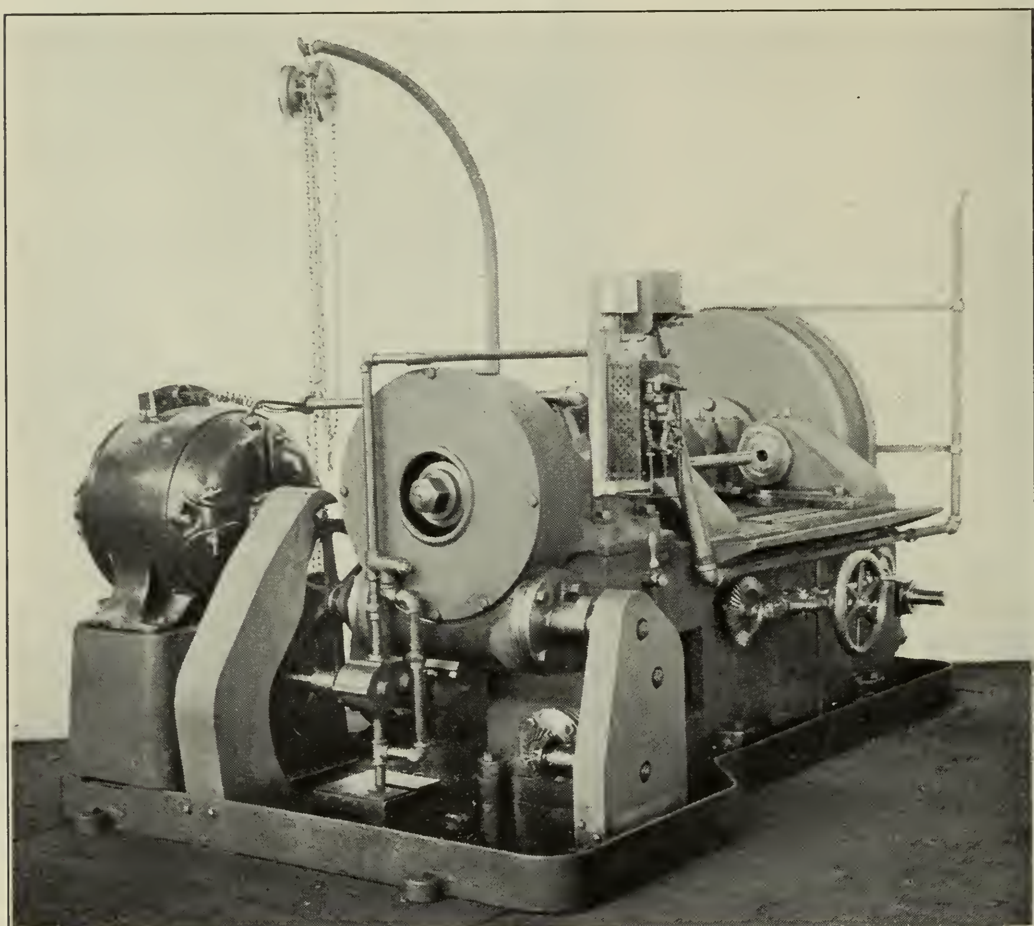
If the motors had an efficiency of 100 per cent., they would consume five times 746 watts, or 3,730 watts at full load; three-quarters of this would be 2,798 watts. Their efficiencies being, however, 84 per cent. and 79 per cent. respectively, they will actually require 3,330 watts and 3,541 watts applied at the terminals, the saving in favor of the higher efficiency motor being 211 watts. 211 watts at 6 cents per kilowatt for 3,120 hours will amount to $39.50.

While this sum in itself is not large, in ten years—which is the conservative life of a motor—the excess of energy required for the machine with the lower efficiency would amount to $395.00. This is more than twice what a first-class high efficiency motor would cost to begin with. In other words, there would have been sufficient savings in about six months to have paid the difference between the high and low efficiency machines at the start; and at the end of ten years the

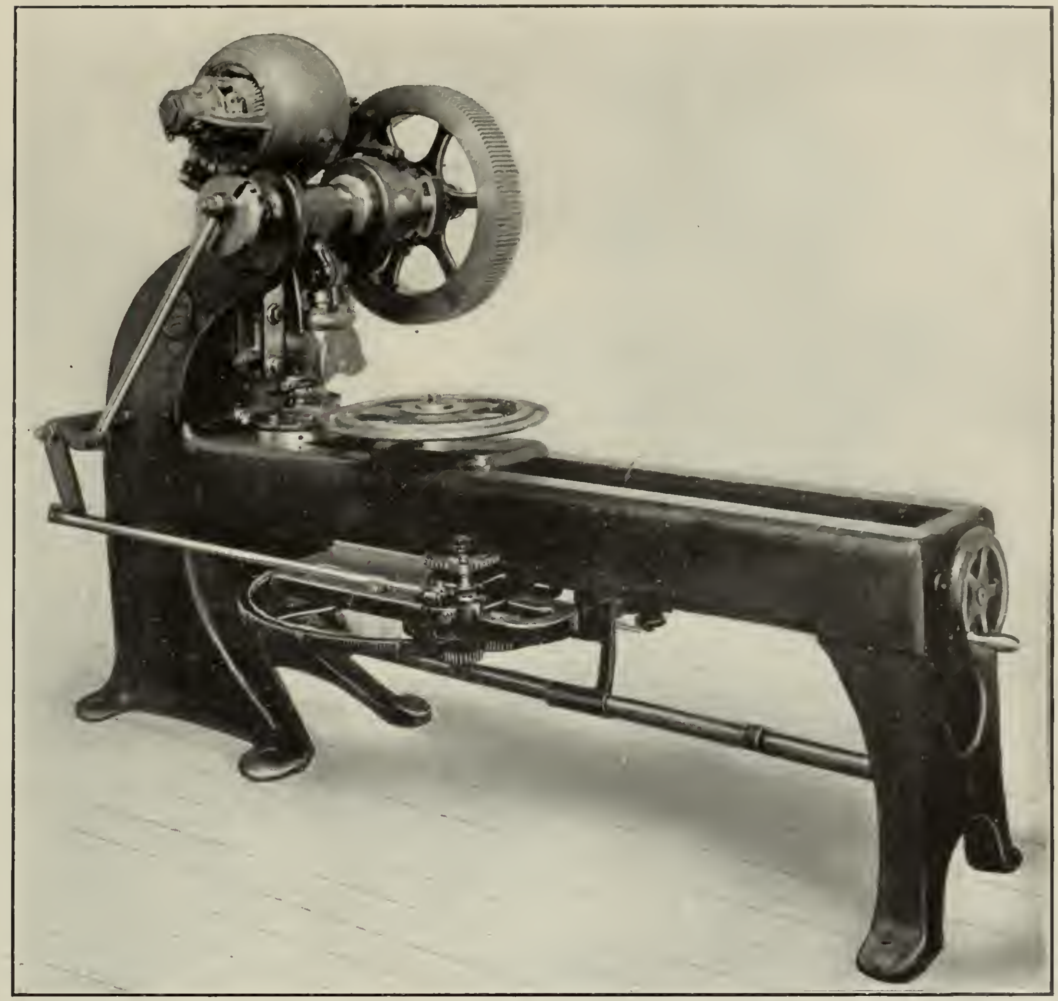


MOTOR-DRIVEN HYDRAULIC MOULDING PRESS AND CURVED ROUTING MACHINE.

R. Hoe & Co. and Sprague Electric Co.



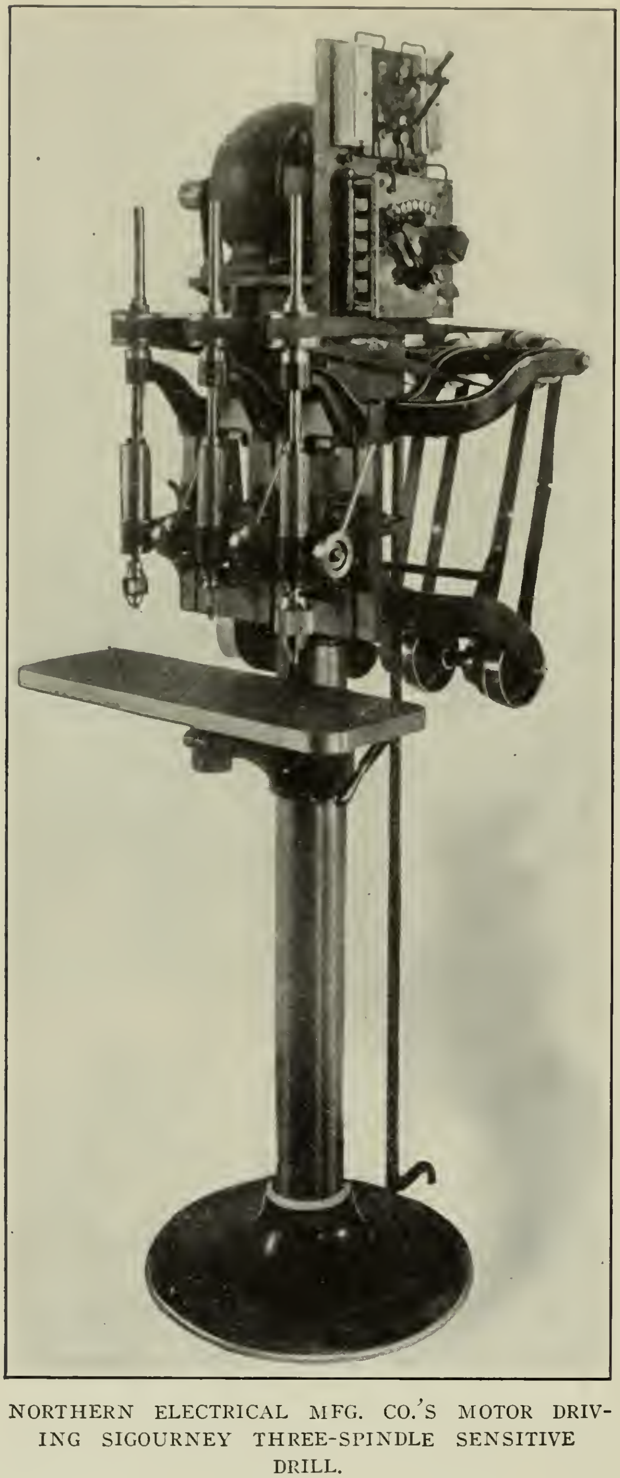
NILES HORIZONTAL GEAR MILL DRIVEN BY GENERAL ELECTRIC MOTOR.



5-HORSE-POWER NORTHERN MOTOR GEARED TO FERRACUTE NOTCHING PRESS.

owner would have saved about $375 in his current bills, had he bought the better motor and paid $20 more therefor. $375 saved in ten years represents annual savings bank interest on a deposit or capital of more than $1,000. It is certainly far easier for a motor buyer to secure for himself an income of $37.50 a year by saving what otherwise would be wasted, than to take $1,000 or more out of his business for deposit in a savings bank, in order that he may enjoy the same income per year therefrom. It is only by the liberal use of material and careful designing that low heating and high efficiency in a motor can be secured, and it is always desirable to pay the slightly increased price for such a motor rather than to purchase a light-weight machine, whose appetite for electricity is, and always will be, rather expensive to satisfy.

In addition to satisfying oneself that the motor selected for purchase is of high efficiency, care should be used to select



NORTHERN ELECTRICAL MFG. CO.'S MOTOR DRIVING SIGOURNEY THREE-SPINDLE SENSITIVE DRILL.

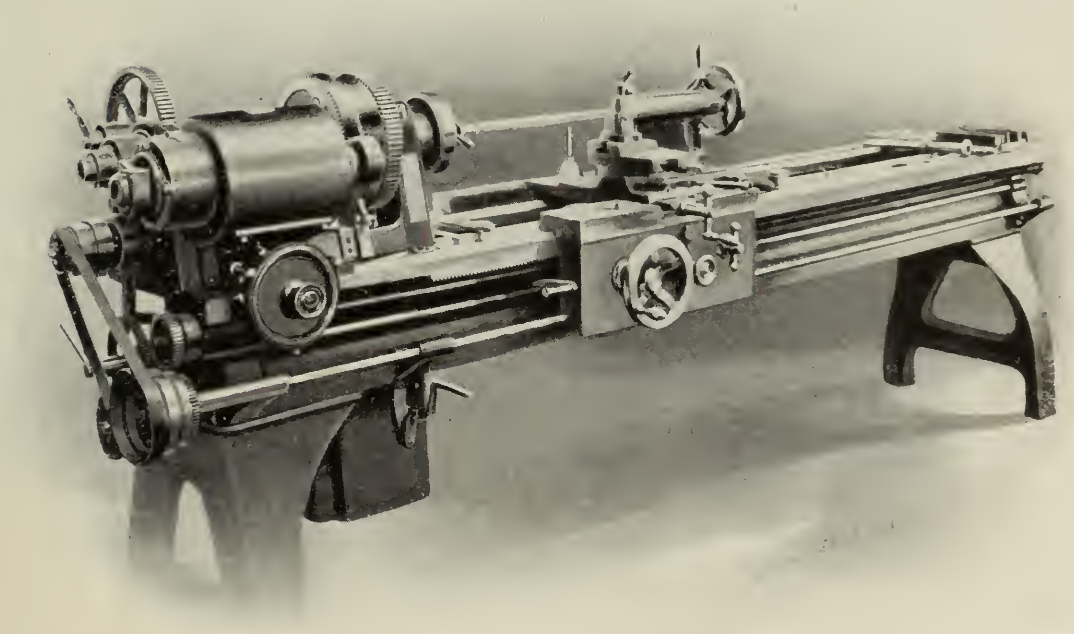
Shown by mistake as Bullock equipment in a former issue.

one that is well designed and sturdy in construction.

The frame should be substantial and of such shape as to enclose and protect the windings, commutator, and brush mechanism from mechanical or other external injury. The bearings should be long, easily renewable, and the oiling arrangements so fashioned as to insure a copious and continuous oil supply without leakage or spattering. The armature shaft should be of ample size with moderately long journals carefully ground to size. There should be sufficient stock in the shaft so that there will be no bending or springing even under heavy overloads. The segments of the commutator should be of generous depth and particular attention should be given to the quality of mica used in its insulation and the means for holding the segments together. The commutator is the most delicate part of the direct-current motor and if it be not of the best design, material, and construction, breakdowns are almost certain to happen sooner or later. Finally, the brush mechanism should be the subject of careful selection;

an elaborate design with multiplicity of parts and delicate adjusting screws and levers should be avoided. Simplicity, strength, and rigidity of parts while allowing flexibility of brush movement should be aimed for.

While a purchaser naturally desires an attractive, symmetrical machine, yet he should never be misled by polished brass and ornamental painting to overlook the absence of those real essentials upon the possession of which the satisfactory operation of an electric motor so largely depends.



LATHE WITH STOREY MOTOR AND ELECTRIC CO.'S EQUIPMENT.

Courtesy of Bernard Macdonald, Esq.

AN ALASKAN SUNSET OVER SEA AND MOUNTAIN.

THE GOLD-BEARING GRAVELS OF ALASKA.

By John D. McGillivray.

THE gold-bearing gravels of Alaska and the Canadian Yukon extend from the 130th to the 141st meridian on the Canadian side, and from the 141st to the 168th meridian of west longitude in Alaska, a total of 38 degrees, or over one-tenth way around the world at that latitude. North and south these gravels are found from about the 60th to about the 70th parallel. They are found along the Yukon river and most of its branches, and on the Kuskoquim, the Copper river, the Seward peninsula, and on streams running into Behring sea. What the actual area of these gravels may be there is no means of judging at present, and will not be for many years to come, because a large part of them are situated far in the interior at long distances from river transportation, and so will not attract the attention of prospectors or capitalists for some time. That they are far more extensive than were the gravels of California has been easily proved by the amount of ground already located. Up to December, 1898, there had been located in the Klondike district alone 35,000 acres, and since then locations have more than trebled that in this district and in the Stewart river country adjoining. In addition to this the Canadian government has granted concessions covering large areas of ground, much of which is of only problematical value, exceeding in area all the ground that has been located by the miners.

It may be said in favor of the values found in the Klondike gravels that they are being worked by very crude methods and without water under pressure, owing to the very shortsighted policy of the Canadian government. In fact, very little gravel in the Klondike country costs less than $2 per cubic yard to work.

PACKING UP THE CHILKOOT PASS, BEFORE THE DAYS OF THE RAILWAY.

In the Forty Mile district on the American side are several hundred miles of creeks along which creek and bench claims have been located. Owing to the stampede to the Klondike of 1896 and 1897 very little work has been done in the Forty Mile country until lately. Last fall something over 1,000 men, many of them with small capital which they had made by mining in the Klondike country, went over into the Forty Mile district to secure claims, either by location or by purchase. As a result it may be expected that this Forty Mile district, which covers an area as large as the gravels of the Klondike country, will within two or three years produce a great deal of gold, part of it from claims worked by the old drifting method, and part of it from claims worked by the use of water under pressure, and by dredges or steam shovels. In the Seventy Mile country last summer I found stakes on every branch of that stream, and this meant many hundreds of 20-acre locations, and I examined some gravel owned by a company that has located a little over 4,000 acres along the Seventy Mile River itself. So it is in the Koyukuk country at the Arctic circle; so it is in the Birch Creek diggings near Circle City, and on the Tannana river, where there was a stampede last winter of several hundred miners from the Klondike and other districts, and in the Minook country, and at Nome and other points on the Seward peninsula. It may be said that a great deal better mining is being done at Nome than at most of the other points along the Yukon, simply because the cost of transportation of supplies is low there. On the Kuskoquim large areas of gravel that promised well were found by some expeditions that went in there in 1901. In the Copper River country some gravel

MAIN STREET OF DAWSON IN THE SPRING OF 1898.

THE HIGHER WHITE LINE IN THE BACKGROUND SHOWS THE BENCH GRAVELS OF GOLD HILL. THE CREEK TO THE LEFT IS ELDORADO. IN THE FOREGROUND ARE THE CREEK CLAIMS OF BONANZA. $20,000,000 WERE PRODUCED FROM THE AREA SHOWN.

mining has been done during the past two years, but most of the men in there are naturally attracted to the copper deposits. I would suggest to any one interested in this matter of gravel to look over the reports of the United States Geological Survey, covering a large part of Alaska, where it will be seen that gold-bearing gravels are nearly always found in large areas all over Alaska.

In any one of these districts which I have named capital can at small cost secure large areas of gravel, from 100 acres up to 1,000 acres or more, to be worked by the ordinary hydraulic method, or with dredges or steam shovels and under favorable conditions. It must be remembered that the lodestone that has attracted the attention of the world to that part of the north is Eldorado Creek in the Klondike country. Eldorado has been worked out, and yet the output of the Klondike is as large as ever, and this output comes from the lower grades of gravel that would not have paid profits under the conditions existing a few years ago.

What I would take as a text for this article is that there are far larger areas of gravel, and as rich in values, on the Alaskan side, from the 141st meridian to Nome and beyond on the north, and to Valdes

THE YUKON BELOW DAWSON.

and to the mouth of the Kuskoquim on the south, than on the Canadian side; and that this gravel may be taken up under more favorable mining regulations, but that the reason why the gravels have not been developed by capital is that the cost of transportation of supplies has been so high. This difficulty can be remedied by capital or by the Federal government in a very inexpensive way, as I shall show later.

The product of gold from Alaska of late has been as follows:

1898	$2,820,000
1899	5,125,000
1900	7,531,835
1901	6,904,000

For the year 1902 the production of gold from the Nome district alone was $5,050,000. What the output of the rest of the country has been I have no means of learning; but this I do know, that into the Forty Mile district, the Seventy Mile, the Tannana, the Koyukuk, and other districts, have gone many experienced miners, mostly without capital, who will do much either toward directly developing those various districts or toward interesting capital in the opportunities that may be found in them.

As I have said, into the Forty Mile district alone have gone during the past year over 1,000 miners, many of them with small capital, from the Klondike country. Several hundred have gone into the

Tannana country, not only from Dawson, but even from the outside over several hundred miles of snow-covered winter trails. It is probable that the mining population of Alaska will be this summer double what it was last summer. However, I do not anticipate a very large increase in the output of gold, for most of these men being without capital will do little more than secure properties to work next season. Quite a number are men who are connected with capital and have gone in with a view of securing property to be placed on the outside.

Next year should show a considerable increase in the yield of gold, for several outfits with capital are preparing for large operations. In the Seventy Mile district on some properties that I examined last summer, the owners (who are London and New York capitalists) are preparing to expend nearly $300,000 for the purpose of bringing in water under pressure of about 200 feet to work several hundred acres of gravel that they own. In the Birch Creek country, John Gregor has put up a steam shovel to work Mammoth Creek. Similar large operations are being undertaken in nearly all the districts now, and this marks a new era in mining in the north—a change from old crude methods to newer and cheaper methods.

The product of gold from the Klondike region during the past three years has been as follows:

THE TWO MEN TO THE RIGHT ARE STARTING ON A 1,600-MILE ICE JOURNEY FROM DAWSON TO NOME.

1899	$16,000,000
1900	22,275,000
1901	18,000,000

During the year 1902 the output was probably about as much as it was for 1901, but the change in the royalty from a direct tax on the output to a tax on the export of gold made the figures appear considerably smaller, and as a result the reports made by the United States authorities and the Canadian government show only about $18,000,000. The last press despatches from the Klondike show that the output for the present season will be about $20,000,000. This will make a total output of the Klondike region—a very small area within about thirty miles of the town of Dawson, and all on one side of it—with what was taken out previous to 1899, about $100,000,000. This

THE GOVERNOR-GENERAL AND LADY MINTO WATCHING A CLEAN UP FROM BENCH GRAVELS.

Lord and Lady Minto are to the left of the author, who holds the pan.

gold was produced by miners without capital. A few companies have gone in there, but what they have produced is a trifling portion of the whole. The mines that are now being worked at a profit are mines which three or four years ago would not have paid at the costs then existing. Few of the mines being now worked at a profit could have been worked two years ago. The total output of the Klondike region near Dawson will certainly exceed $300,000,000 and probably will be much larger.

Down on the American side a few miles from Dawson comes first the Forty Mile district, where there is available an abundance of water for hydraulicking and good dumping facilities and other conditions favorable for capital to work on large scales. The season during which hydraulic mining can be carried on is a little over four months.

DOWN THE YUKON ON A SCOW.

The same conditions exist in the Seventy Mile, Charlie River, Birch Creek diggings, the Koyukuk country and at the Minook and on the Tannana. In each one of these districts are large areas of gravel, sometimes as much as 1,000 acres, contiguous and to be acquired as one property, with good dumping facilities and with water in the neighborhood available that may be brought on with pressure of from 100 to 200 feet above bed rock in ditches not to exceed from 5 to 10 miles in length.

I have examined a good many of these gravels by sampling with pans and found that the values were very uniform, and as a general thing of a very high grade. For example, I examined some property last summer, about 200 acres in area, in the Seventy Mile country which showed values of a little over $6.00 per cubic yard for a depth of 12 feet.

MAIN STREET, DAWSON, ON THE QUEEN'S BIRTHDAY.

THE FOURTH OF JULY IN DAWSON.
A large majority of the Klondikers are Americans.

As to the Nome country and its values I would refer to the reports of the U. S. Geological Survey, which show that the gravels cover a great many square miles of territory and are a very high average value. As to the Kuskoquim country it is only necessary to say this—that mining men have gone into that country at considerable expense and found gravels similar to those in the Forty Mile and Seventy Mile country, but have been unable to do anything on account of the cost of transportation of supplies. In the Rampart or Minook district are large areas of gravel of high grade, but this like all the rest

THE YUKON NEAR DAWSON. IT IS NEARLY A MILE WIDE.
The figure is an Indian chief in his birch-bark canoe.

of the country, is not being developed simply because the cost of transportation makes mining almost prohibitive.

In Siberia with the same kinds of gravel considerable mining is being done, but there, as in the Canadian Yukon, the government is the principal deterrent element. In Alaska the laws are liberal, the regulations as to acquiring mining property very satisfactory, and the United States Government through its Geological Survey and the War Department has done much to develop the resources of that country. But what is wanting above all things is assistance from the Federal Government, either by indirect or direct taxation to improve the means of transportation. The Federal Government has treated

"MUSHING" WOOD WITH WHICH TO THAW GRAVEL.

Alaska very well by having made very good geological surveys and by giving police protection through the Army Department.

I would suggest that the gold miners do not ask anything unreasonable from the Federal Government. I think it may safely be said that miners are always willing to pay their own way. And now I want to suggest a means by which, with the consent of the Federal Government, we can at our own expense pay for wagon roads and trails and so reduce the cost of working as to open up large areas of gravel which do not now pay a profit.

The Federal Government has made provision for irrigation of barren parts of the West out of the sale of public lands. I would suggest that all moneys received from the sale of gravel mines in Alaska be turned over to the War Department to be expended for the building of wagon roads in the different districts of Alaska. At first the income from this source will not be very large, because the Federal Government has not provided land offices and the other machinery necessary to acquire patents for claims. As this source would not bring in revenue enough to satisfy Mr. Cannon of Illinois, I would suggest another source of revenue, and that is that a tax of say one dollar or two dollars per year be levied on each claim located in Alaska, to be expended for the same purpose and in the same way. Such a tax would do much to keep titles clear, for the simple reason that if the regulations were properly made out no claim owner would be able to hold title without showing a receipt for the payment of his tax. I may say in this connection that in many cases, not only in Alaska but in other parts of the west, we do not know whether claims have been abandoned or not. The payment of this tax would show that the claims had not been abandoned. I know of one outfit in the Seventy Mile country backed by New York and London capital which has over 200 claims of 20 acres each. It will soon apply for patents for its properties, and would pay into the Federal treasury $10,000, which it would gladly see spent on wagon roads to reduce the cost of transportation.

Let it be supposed that not more than 50,000 claims are located in Alaska. This would mean an income of $100,000 per year. Yet in addition to this income, if the Federal Government will give us better facilities for obtaining patents to claims located, a great deal will be added to the Government's income. If Congress would agree that these sums should be appropriated for the building of roads it would very much increase the output of gold and copper and other minerals in Alaska. It would be only fair on the part of the Federal

NO. 16 ELDORADO, SHOWING DUMPS OF GRAVEL THAWED BY STEAM AND HOISTED. THE CLAIM IS BEING WORKED BY A DREDGE.

Government to make advances of money to be expended under the direction of the War Department of from $1,000,000 to $5,000,000 in building roads and trails throughout Alaska, with the understanding that this sum was to be paid back to the government out of the sale of mineral lands or out of a tax, such as I have suggested, of from one dollar to two dollars per claim. Miners, gold miners, have always done more than any other class of people toward developing the re-

OFFICE OF ONE OF THE BIG MINING COMPANIES ON THE BED ROCK LEVEL OF BONANZA BENCHES.

sources of the great West. Were it not for the discovery of gold in California in 1849 there would not have been built a transcontinental railway until many years after 1868, and to-day much of the great country west of the Mississippi river would be practically a wilderness.

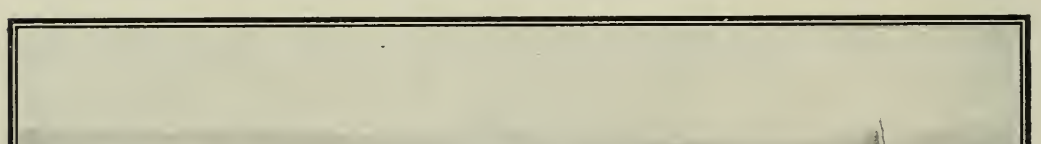
There went into the Yukon country in the summer of 1897 at least 5,000 people, and in the summer of 1898 about 40,000. Of these nine-tenths were not fitted for the strenuous life there. Many who went in came back to civilization without making any attempt to acquire mines or to mine. Of the rest nearly all were men who had mined in the west, or were merchants, or were fitted in other ways for the hard life there, and of these nearly all have done well.

The Canadian government east of the 141st degree placed upon mines most difficult, and in point of fact, ridiculous, regulations which

A SUGGESTION THAT THE WEATHER IS SOMETIMES WARM.

A DOG TEAM IN FRONT STREET, DAWSON, SUMMER OF 1899.

POLING UP STREAM.



DAWSON FROM "THE SLIDE," 3,000 FEET ABOVE THE CITY.

MOONLIGHT PHOTOGRAPH OF THE YUKON VALLEY NEAR DAWSON.
The picture was made with two hours' exposure, on a winter night.

tended to retard mining or any other industry. However, in spite of all this, on account of the very good values found in the gravel of the Klondike country, a great many of the experienced miners who went there in the early days made money. The result was then, as it was in California in 1849-50, that a very few, and only those who were capable of doing good work in any direction, succeeded. Nine-tenths of those who went to the north were unfitted for the work that it was necessary to do there, and they returned to the States or other parts of the world from whence they came. These men condemned the Klondike, condemned the whole Yukon, and told the rest of the world that there was up there no opportunity for miners. This has done much to give the Yukon a bad name. Yet never a miner who understands gravel has gone into the north who has not said that it is one of the best gravel regions in the world. The best proof of this is that a large proportion of the mine owners of the Klondike who have made fortunes, and most of the miners of experience on the Alaskan side, all the way from the boundary line to Nome, return to that country every year and say that they know of no country in which they would rather live and do business than along the Yukon.

I know what answer will be made to this by the average man in New York and San Francisco. He will say that the climate is bad.

FIRST AVENUE, DAWSON, ON A WINTER NIGHT.
With the moon and the northern light, a winter night even is not very dark. This picture required a two hours' exposure.

I have spent five winters on the Yukon and the past winter in London and New York, and I must say that we have a better climate on the Yukon in winter and in summer than either in New York or London. With us the air is dry. There is no wind. And while the thermometer goes down in winter to as much as 70 degrees below zero (though it is seldom more than 50 degrees below) having no wind and having no dampness in the atmosphere, we wear less clothes and suffer less inconvenience than we would in New York or London in the colder days of winter, or in San Francisco with its fogs and winds.

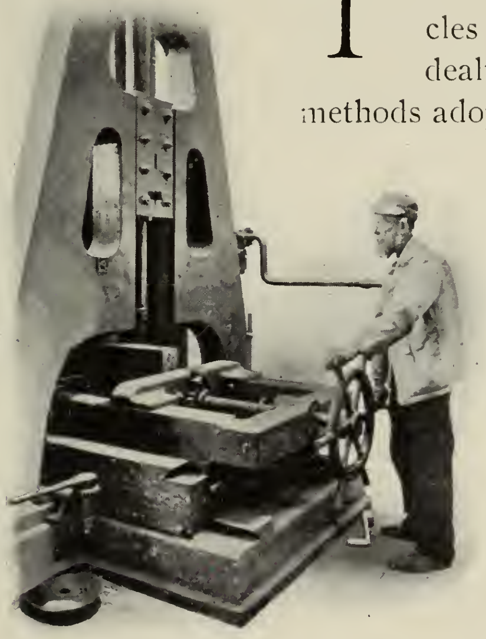
It is proposed to build a railway from Valdes through the copper country to Eagle, on the Yukon, and on to Dawson. At Eagle are the principal United States army headquarters of the Yukon and the officials of that district. With its branches this road would be 500 or 600 miles in length. The grades would be light and the cost of operation comparatively low. The Federal Government should do what it can to encourage any such undertaking, for two reasons. The first is that it would do much to develop a great deal of the country in which there is large mineral wealth not to be reached by water transportation. The second is that it would give the United States control of nearly all the trade of the Canadian Yukon.

THE PROMOTION OF INDUSTRIAL EFFICIENCY AND NATIONAL PROSPERITY.

By John B. C. Kershaw.

III. PAST HINDRANCES, AND A SUGGESTED MODIFICATION OF THE AMERICAN PREMIUM SYSTEM.

In the preceding article of this group, which appeared in our June number, Mr. Kershaw pointed out that "the machine is now ahead of the man" in productive efficiency in the machine shop, and that the great problem of modern economics is to make the worker willing and satisfied to obtain from modern machinery the highest possible yield. He then gave, in brief form, the main outlines of the labour systems of the most successful employers of the Continent, Great Britain, and the United States. A following paper will take up chiefly the question of unionism and its influence on the case.—The Editors.



THE details recorded in the preceding articles have shown that in the three countries dealt with, great diversity characterises the methods adopted for promoting the efficiency of labour, and for obtaining active co-operation of the worker in the particular industry in which he is engaged. Reasons have been given in the introduction to this series of articles, for the belief that the modern conditions of work, and extensive use of machinery in all highly developed industries, demand some change in the methods of rewarding labour. As this opinion may be controverted, two extracts are given to show that the opinion is held by men whose ability to judge in this matter is unquestioned.

On December 27th 1901, Mr. George Livesey—of the South London Gas Company, writing to *The Times* on the "Crisis in British Industry," expressed himself as follows:—

"The wage-hire system as a transitional step from slavery and serfdom to the ultimate goal of partnership in some form was doubtless the only practicable method. When businesses were small and masters and men worked together there was very much in its favour, and the results were satisfactory; but the entire change of circumstances—the development of the factory system, the growth of enormous businesses, and the influence of the trade unions—has divorced employers and *employees* (they must no longer be called masters and men) and produced the present extremely unsatisfactory position. The old ties between the parties are broken, the only connexion in the building trades, for instance, is an hour's time, an hour's pay, an hour's notice—and those who should be friends and in some real sense partners, are in constant antagonism. So far as I could understand Mr. Ashbee I disagreed with him, but there is a sentence which he puts into the mouth of a workman which is perfectly true. He tells us the workman says, 'My employer's business is his business and not mine.' This is the sole and simple reason why the workman takes no interest in it, and this is the position to which the simple wage-hire system has brought British industry. It is the old story; the circumstances have changed, we have adhered to our old methods, and only on the pressure of very urgent necessity shall we think of altering or modifying them.

"We cannot go on as we are. You, Sir, have materially helped to make that impossible; but in what direction must the remedy be sought?"

A paper on "Works Organisation" read by Mr. Tom Westgarth before the North East Coast Institution of Engineers and Ship Builders at West Hartlepool in January 1899, contained the following remarks on payment by results:—

"The writer is satisfied that modern developments and the present-day system of very large works, often controlled by non-resident directors, has been the cause of losing much efficiency through the loss of the personal contact between masters and workmen, and he thinks that everything that is possible should be done by those having the control of large works to foster a friendly spirit between master and workmen. This can of course only be done satisfactorily if the advance is made from both sides, but necessarily the first steps must be taken by the masters. He is also of opinion that more attention might be given to the consideration of profit-sharing, notwithstanding the poor results which have followed efforts in this direction in this district, and he invites the members of this Institution to discuss this subject fully this evening.

"The writer strongly recommends the principle of payment by results, from the managers to foremen and workmen. Managers should be paid partly by a percentage on the profits of the works or of their department; foremen should be paid partly by the bonus upon the quantity of work turned out, providing always that it is satisfactory, and workmen should be paid by piece work, which should, if possible, be supplemented by the comparatively new bonus system, and he sees no reason why apprentices and boys should not also work by piece.

"The writer looks to the gradual, careful, and persistent introduction of the system of payment by results, as being one of the most hopeful means by which we shall be enabled to hold our ground against foreign competitors, and he is of opinion this question is one which will bear very careful consideration and discussion."

These opinions of men in positions of authority reinforce the argument in favor of a general change from the "*laisser faire*" principles which have too long dominated the relations between employers and employed.

Each of the systems of treating the workers described in the preceding articles has some particular merit, but their efficiency as devices for increasing the contentment and output of the worker varies greatly. The agencies for promoting the social and physical comfort of the workers, found in many of the German and in a few of the English and American works, are eminently satisfactory from one point of view, and undoubtedly tend to improve the health of the workers and their families, and to promote good relations between the heads of the firm and their employees. But these agencies do not promote the output of work to the extent that premium or bonus payments promote it. As the battle of industrial competition will in the future be fought largely on the ground of rapid manufacture, it is probable that a modification of the bonus system, on the lines of the American premium system of payment will be generally adopted on the eastern side of the Atlantic. Such a system need not displace the agencies for promoting the social and physical education of the workers already established, but might be worked in conjunction with these. Possibly this will be the case in the more up-to-date works in both countries. My belief that a modified form of the American premium system will displace other profit-sharing systems of payment, is based on the fact that most men, (whether workers or capitalists) prefer a pound in the pocket to a post-dated cheque on a shaky bank, and would rather receive a premium of 50 per cent. on their income paid *weekly*, than a bonus of 5 per cent. or less, paid *annually*. That this is not an unfair statement of the relative rewards offered by the two systems, is proved by comparing the statement as to the average amount of the premium received by the workers in the Westinghouse Company's works at Pittsburg, ranging from 25 to 100 per cent. on the weekly wages, with the Board of Trade report* upon the results of the profit-sharing system in operation in 58 English works, employing 20,000 workers, in the year 1901. In thirteen instances no bonus at all was earned, in twenty-three cases the bonus was under 5 per cent., and in only five of the works did the bonus exceed 11 per cent. The mean bonus for the whole of the works was 5 per cent. Under these circumstances, it is perhaps not surprising that many manufacturers dispute the advantages to be derived from the system of profit-

* The *Labour Gazette*, July, 1902.

sharing usually adopted in Great Britain, and that every year firms fall out of the ranks of those who continue to practise it. The latest withdrawal from the ranks of profit-sharing firms is the Brush Electrical Engineering Co.—of Loughborough—a firm employing between 1,500 and 2,000 men.

From the Board of Trade reports on profit-sharing in the United Kingdom it may be found that up to the end of 1899 over one hundred and seventy-eight firms had tried schemes of profit sharing with their employees, and that of this total, ninety-four had discontinued them, after longer or shorter periods of trial. The reports give details of all these failures, with the assigned causes when these could be ascertained. The chief causes which have operated to produce failure have been—

I. Failure of the business to earn profits.

II. Dissatisfaction of the employees with their share of the profits, when earned.

With regard to the first, this is a condition of affairs that would wreck not only any profit-sharing scheme, but ultimately the business itself, and failure from such a cause cannot be held fatal to the principle. If any firm fails to earn a profit for a continuous series of years, it is evidently necessary for that firm to be placed under more efficient management, or to withdraw from manufacturing operations which do not pay.

The second cause of failure is that which has most hindered progress. The fact that so many firms who have adopted profit sharing, have discontinued it in a few years on account of the dissatisfaction of their employees, has certainly prevented other firms from experimenting on their own account in this direction.

From the figures published in the Board of Trade reports for the period 1896-1899, we find that the mean bonus in that period on the wages paid amounted to 6 per cent. Taking the case of a worker whose average earnings the whole year round are 25 shillings per week, we may calculate that in a year of 300 working days he will have earned £62.10, and that his share under the bonus system will amount to £3.15, or an average of one shilling sixpence per week. This is but a very slight incentive to better work.

Probably when the scheme was inaugurated with great expectations on both sides as to the advantages which would accrue, the employee had not realised that the final outcome would be equivalent to such a small addition to his weekly earnings, and his disappointment is proportionately great. On the other side there has been the employer, conscious that he was voluntarily surrendering a portion of his profits to the workers, and hoping that this might lead to better work and to a greater devotion to his interests. During the first year these results were to some extent attained. But when the second year was entered upon, and the disillusioned employee fell back to his former level of inefficiency and indifference; the employer saw little use in continuance of a scheme which diminished his profits, without increasing the efficiency of his servants. Such, without doubt, has been the history of many of the failures. A study of recent figures would seem to indicate that more failures from this cause may occur. In 1901, the bonus payments of thirty-six, or more than one-half of the total number of firms making returns, were less than 5 per cent. on the wages.

The difficulty might be overcome by making the profit-sharing scheme more attractive to the average employee. This could be effected by increasing the bonus fund to an amount equal to between 20 per cent. and 40 per cent. of the annual wages, and in paying, say one-half or two-thirds of this, weekly, instead of annually. The amount of this weekly payment would be based on the efficiency of the employee's work, and would be calculated in engineering works by the Halsey system. The remaining one-half, or one-third, would be invested in the name of the individual worker in the Company's ordinary shares, and would carry the usual rate of interest. When a worker left the employ of the firm, he would receive a cash payment equivalent to the market value of his shares, plus the accumulated interest. Employers will of course argue that such an increase of the bonus fund would swallow up the whole of the present profits of their businesses. That is possibly quite true. We are dealing, however, not with *present profits*, but with *future profits,* and such an increase of the bonus fund would undoubtedly pay, in many of our manufacturing industries. It has been shown that the mean bonus received by the workers under the schemes of profit sharing at present in force is equivalent to an addition of about one and sixpence per week to the wages of the average working man. Supposing that the addition were 10 shillings per week, in place of one shilling and sixpence, and that a working man whose ordinary wages were say 25 shillings per week, had a chance of increasing this to an average of 35 shillings by the introduction of the proposed modification of the usual system of profit sharing. Would not this possible increase prove a very effective incentive to better work, and to greater devotion to his employer's interests?

The experience gained in the course of the erection of the buildings for the new factory of the British Westinghouse Company at Trafford Park, Manchester, in 1901, shows that most astonishing results can be obtained from British workers, when facilities are offered for rapid output, and when this is promoted by wages rather in excess of the trades-union rates. The number of bricks laid per man during the building of this factory at Trafford Park was *three to four times greater* than is customary for the same class of work in the United Kingdom, and the figures published in the *Times* last year have been disputed by trades-union officials as incredible. In view of this experience, it is not unreasonable to assume that the general adoption of the proposed modification of the bonus system would have a remarkable effect in promoting the output and prosperity of many manufacturing industries, and in enabling British manufacturers to meet more effectually the new conditions of international competition.

In the final article of this series, the writer will dicuss the future of bonus and premium systems of payment and the trades unions' hostility to their extension in the United Kingdom and in America.

THE COMMERCIAL MANAGEMENT OF FACTORIES.

By Ian Andrews.

In an article under this same general title which appeared in our issue for February last, Mr. Andrews discussed the relations which the office manager, or managing director, should bear to the organisation of the works and its commercial policy. The supplementary portion of this review, now presented, considers his relations and functions in the direction of cost reduction.—The Editors.

BEFORE erecting new works, the adaptability of the proposed factory to its special purpose should be a first consideration, and where practicable the locality chosen should be convenient to the principal markets and a centre of labour, and in proximity to the source from which raw material is chiefly obtained. Such a combination of advantages, however, is perhaps seldom attainable, and even when possible, may be too costly.

Ground rents and the cost of land in populous commercial centres are usually very high, and manufacturers are therefore at times compelled to erect works at some distance from industrial centres, in which case they frequently attract sufficient labour by providing cottage accommodation for their employees at fair rents to yield a return on the investment.

In an established factory the manager may have many difficulties to contend with if the works have not been carefully planned in view of all circumstances, and the most he can do in such a case is to minimise the consequent disadvantages by judicious internal economies and by structural modifications.

Unless the factory is arranged in such a way that the different stages of manufacture are carried out in progressive order, there will be a considerable amount of unremunerative labour. The ideal factory is that in which there is no unnecessary handling of raw material and in which everything when received at the works is stored so as to be readily available for the various departments, and thereafter so handled throughout the whole course of manufacture that it will not go through any backward movement, but from stage to stage, until ready for the market.

When other considerations are favourable, it is an advantage to construct factories as far as possible on one floor, so as to minimise labour; for it is obvious that otherwise the cost of handling will be very considerable, everything that is taken up stairs having to be brought down again.

The shops should be provided with all the daylight available—which in the case of those on one floor can be readily attained—and they should be so arranged, that the respective foremen can see all that is going on, as, when they have each to supervise a number of small shops, much time is lost and the supervision is less effective than when the foremen are so to speak, on the spot.

In stores requiring a number of assistants, to give out material to the workers, it is desirable, as far as possible, to deliver stores only between certain hours, for, when men are irregularly coming and going, their own time and that of the store keepers is unnecessarily wasted, the latter being also called away from other work, such as stacking and counting goods, or writing out their accounts, and the accuracy of their work consequently suffers.

These remarks are directed against unnecessary labour, but there is also the prevention of waste to consider. Preventable waste, in the aggregate, accounts for millions of money, and in a single factory may amount to hundreds or thousands. It therefore behoves all concerned to detect and avoid it—or rather to minimise it, for in large factories this may be the most that can be attained, as very much depends upon the individual efforts of employees. If, however, a good feeling exists between master and workmen, and both appreciate the fact that their interests are bound together, large economies will result. This principle is the basis of profit-sharing schemes, and its application under favourable conditions leads to reduced cost of production, by the exercise of economy, while it also benefits the employees pecuniarily.

I cannot here enter into so large a subject as that of employees' profit sharing, or into the premium system for special industry, but it will be obvious that, if the relationship between employers and workers is satisfactory, waste will be greatly minimised as a result of voluntary effort. Frequently waste arises through thoughtlessness. This is specially noticeable in the consumption of gas, which is often in excess of requirements, either because used extravagantly, or without regard to the best burning conditions, or because of original faults of installation in regard to the position of the lights, which first and last objections may apply to the use of electric light. In this connection regular readings of meters should be taken and compared with previous records in relation to the output, number of employees, or other convenient basis.

In these days of trades unionism, the employer cannot afford to ignore its existence, and with fair-minded men, he will gain their confidence, by recognising their Union; within reasonable limits, for, if they are satisfied as to his *bona fides* there is not much to fear regarding its undue influence.

It is an employer's duty to look after the comfort and improvement of his workers, as far as possible, and happily we have notable examples of what may be done in this direction, by not a few large employers of labour. It is of course imperative that the risk of accident be minimised by all possible precautions, for the protection of life and limb; but having done all this, it will be advisable to insure against the monetary risk of accident.

I attach great importance to the co-operation of employees, in regard to the methods of production. Many intelligent workmen could suggest improvements, but for lack of encouragement they feel it no business of theirs to do so. Such a state of things operates against all interests, and the sooner it is altered the better will it be for all concerned; for inventive genius should at all times be encouraged and suitably recognised. If it is not, the employer may not only lose the benefit of his workmen's suggestions, but may find that their ideas have been carried to trade competitors, with the result that valuable inventions are developed and monopolised by others, for a number of years, to the former employer's permanent loss.

It is obviously an advantage to retain workmen in as regular employment as possible; otherwise the services of good men may be permanently lost to the firm—although as a matter of course, these should be the last to be discharged when there is a business lull. Old servants should always be encouraged, having generally a greater interest in their employer's business than new hands; at the same time the infusion of new blood into the various departments is desirable, as one cannot afford in these days of keen competition and progressive industrial methods to be too conservative of old ideas, which may be capable of improvement.

Inefficient workmen, like poor tools, are dear at any price; and it is therefore essential that only capable men be employed, and that they receive good wages. Regularity and punctuality should also be insisted on, for it is a source of loss to run a factory when a number of employees are absent or systematically late in arriving at work. As a fixed amount of running expenses is incurred during a working day—for supervision, power, artificial light, heat, and other items—it follows that the vacant bench is unremunerative.

Whether the employees should be paid by piece or day wage—either with or without a premium for industry—will depend largely on circumstances and the nature of the work produced. In some trades piece work may be a source of danger, as in the case of work which has to be mathematically adjusted, where such a system of payment might lead to careless finish.* Where, however, the nature of the work will permit, and where there is careful supervision, there can be no doubt that employer and employee benefit under the piece-work system, so long as earnings are equitably adjusted. Employers should however see that labour really benefits by the system, for workmen cannot be expected to give their best energies without some distinct monetary gain. In other words, the advantages of piece work or any premium system must be fairly divided.

In the purchase of raw materials, it will be found advantageous to make out specifications of requirements, at regular intervals, when the several store keepers should furnish stock sheets, to enable the manager to estimate his requirements. Quotations will then be obtained from leading houses, and orders placed accordingly, delivery being taken by instalments during the period which will elapse before the date of next ordering. It is a mistake to be frequently buying goods just as tsocks require replenishing, for there is then a serious risk of running short. When however, the replenishing of stock is considered at regular intervals, the matter receives more careful attention and the requirements of each period can be compared with those of the previous or corresponding one.

Generally, better terms can be obtained for large purchases, and in such cases it is desirable to place orders for the several branches when buying for the parent establishment, for, though orders may be placed at one time, delivery, as a rule, need only be taken to suit the convenience of each branch. Frequently it may be desirable, to make contracts for a lengthened period, especially at times when market prices are low.

* This is a natural apprehension, but is not borne out by facts, as will be apparent on comparison with Mr. Colwell's article in our May number. The fact proves to be that the ambitious workman under the piece-rate or premium plan realises that he has more to lose than his employers from defective work, and that such work will certainly be found and rejected by the inspector.

While the cost of production should be minimised by all legitimate means consistent with the maintenance of quality, it is no less important and necessary that a complete system of cost keeping be adopted. Many firms are satisfied with more or less approximate costs, because, at the end of the year, they find that there is a fair margin of profit over all; but without accurate costs they cannot tell whether on some branches they are not losing money.

In order to facilitate the costing of all manufactured goods, there should be a book of "Prices Current" showing the latest cost of all purchases; from this, together with the works' job books, the cost of manufacture is readily ascertained. It is a serious loss of time to refer to invoices for the cost of materials, as the work has frequently to be repeated when revising costs; but when the invoice clerk who checks all inward invoices enters up the latest prices in alphabetical order in "Prices Current," the information is readily available, and greatly facilitates the work of the cost clerk.

Wages books should be carefully analysed, in order to obtain accurate costs; and if weekly wages totals are compared in relation to output, it will facilitate the detection of error or mismanagement.

The question of working expenses has a most important bearing on the profits, for as the expenses of conducting a business are high or low, so will the dividends be inversely affected. For a minimum output, certain charges, such as rent, rates, taxes, insurance, management, supervision, salaries of clerks, etc., are necessarily incurred each year, and will vary but little, with any output, between that minimum and a certain maximum. For example, say that the annual sales amount to £250,000 and the working expenses to £30,000; it is conceivable that, if such sales were increased to, say, £300,000, the expenses might not greatly exceed the above figure, or at all events would not increase in proportion, simply because the same establishment is equal to the increased trade; or, in other words, the resources of the factory are not in the first instance fully employed. If the output be only three-fourths of the factory's capacity, it is clear that these three-fourths are bearing, say, one-fourth more of the establishment expenses than might otherwise be chargeable, and that being so, it is equally clear that, if the output be increased to the full capacity, the profits will increase, even though the additional business be less remunerative, provided that the selling price is not bare cost, but carries with it a margin for working expenses. But before advocating any policy that might suggest itself on arriving at this conclusion, it is first assumed that the output has been and under ordinary conditions is likely to remain, stationary, and that the manufacturer has no specialty to take the market. A demand has to be created, and cheapness primarily is, in these days of competition, the great means to this end. Let us look at the case of gas companies, who, to induce an increased consumption, sell gas for motive power and other purposes at a lower price than they charge for lighting. They can afford to do so, having already the plant and facilities for their ordinary make, and the working expenses connected with the manufacture and distribution of the increased quantity are comparatively small. Although the case of a gas company and that of a manufacturer are perhaps, not alike—the company having a monopoly which the other has not—the principle involved is the same, and it may be recognised in the shape of contracts. Contracts on a large scale are sometimes taken at prices which would not pay on smaller business, but which, as bringing additional grist to the mill, keep the factory fully employed and earn a profit, however small. The fact that the manufacturer has generally no monopoly reminds us that he runs the risk, when selling cheaply to large buyers, of having to reduce his prices to smaller consumers. He has, however, in that event the advantage of a factory fully employed, enabling him to compete successfully with others, should they compel him to reduce his prices generally. Even if he does not accept contract work at low prices, but leaves it to other manufacturers, he will still run the risk of competition without having the advantage referred to. In other words, competition on the part of a few affects the many, by lowering prices, and it is therefore advisable to be early in the field, and to take the advantages offered by a good going concern to minimise the rate of working expenses. The percentage of working expenses may also be minmised by an established factory, which is only partially employed, branching out into another line of business more or less allied to its own, for which it may be adapted. Having already a fully equipped establishment for its staple manufactures, it may be able to produce other goods at less cost than a factory more narrowly confined in its operations.

While the foregoing remarks indicate the possibility of increasing output without a proportionate increase of working expenses, it is often possible to reduce the actual working expenses without affecting the efficiency of production. Too often working expenses are allowed to eat into the profits of a business without a due appreciation of the fact. It is therefore very desirable to scrutinise all expenditure under this head, for which purpose an analysis of the periodical accounts should be made. Each item of expense can be worked out as a percentage on the sales, or other convenient basis, and compared with previous years figures. If the total of sales is taken as the basis, allowance may have to be made for fluctuations in selling price, and for this reason some fixed unit is to be preferred for comparison.

In conclusion, I would recommend that in the counting house, there should be a regular monthly audit at least as comprehensive as the official audit, which is generally conducted after the balance is struck. The management should not be satisfied with an audit which takes place only at long intervals. The real object of an audit should be to check errors immediately, not merely to detect them several months after they have been made, when the delay may have serious consequences. Part of the duties of the audit department will be to submit periodical returns and analyses, so that the progress of the business may be observed and errors of administration remedied.

The foregoing remarks will suggest to the manager numerous details having a bearing on the subject, which he can critically investigate for himself, with, at least, one good result—that, if he is unable to economise—(and he will surely find *some* room for economy) he will have the satisfaction of knowing that nothing has been overlooked in the administration of his business. Finally, he will bear in mind the necessity of providing, as far as possible, against the exigencies of strikes, fluctuating markets, and any risk likely to bring his works to a standstill, and he will seek to cultivate that kindly interest in his employees which goes far to secure faithful and profitable service.

THE USE OF IRON PIPE IN STRUCTURAL WORK.

By Egbert P. Watson.

The list of possibilities opened by Mr. Watson's suggestions would extend to a long catalogue. His article will serve the purpose of giving an idea which the managers of many industrial establishments can no doubt develop advantageously to suit their particular needs. --THE EDITORS.

THE facility with which commercial iron pipe bought in open market lends itself to building purposes, in so far as stress, strain, and flexibility in design are concerned, is remarkable, and it should be more generally used than it is for various purposes. A marked economic feature in the use of iron pipe is found in the great variety of connections, or fittings as they are called in the trade; these permit of almost endless combinations and adaptations to special situations, and, in comparison with wood, cost very much less, when the waste of material and the item of labor in wasting it are considered. Add to the foregoing citations the ease with which the material can be fastened together, the rigidity and lightness of the whole structure in comparison with wood, and we have a strong case for the employment of iron pipe, or steel if preferred for structural work, wherever it is possible to substitute it. In tropical countries, where insects destroy wooden buildings quickly, iron pipe lends itself as a material to check their ravages most admirably, and as it can be built up in any form in a shop and then taken down and re-erected by comparatively unskilled labor where it is to be used, it would seem worthy of attention as an enterprise.

I do not claim to be the discoverer of iron pipe in structural work, for it is now used in many situations for which it is obviously suited—railings, for example; but this appears to be the only case where it is generally employed, when, as a matter of fact, its range is very wide—so much so that I have ventured to call attention to it.

Figure 1 is a church steeple constructed wholly of iron or steel pipe so far as the frame is concerned. The connections can all be purchased in open market, and the whole structure is fire-proof if slates be used in lieu of shingles or weather boards for the exterior; the only wood employed in it is in the ceiling and furring strips to which it is attached; these last are covered by the slates and not exposed externally.

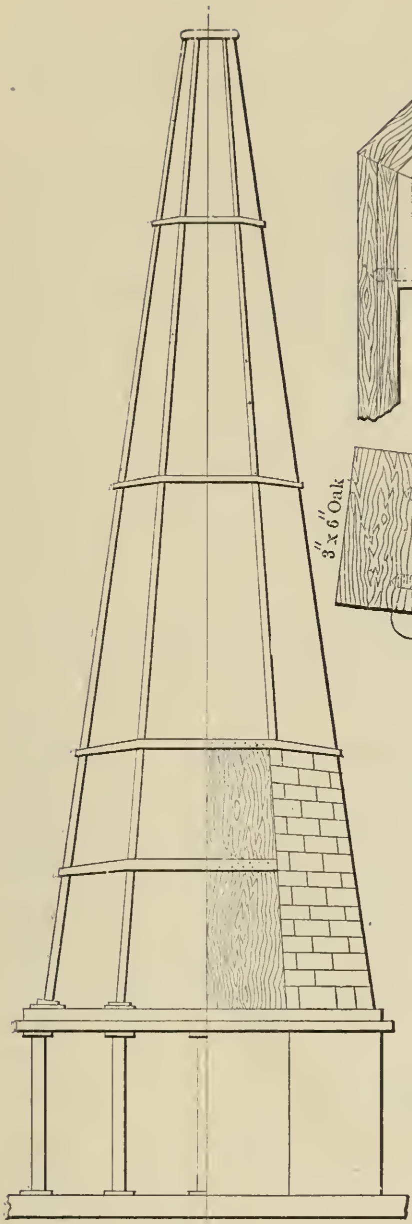


Fig. 1

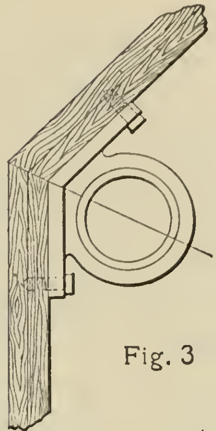


Fig. 3

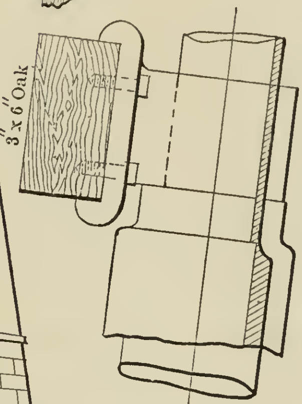


Fig. 2

A STEEPLE MADE OF ORDINARY PIPE AND FITTINGS.

Now if we consider the rapidity and ease with which such a steeple can be erected without any scaffolding, its decreased cost in all directions—labor, material, time, and other items which enter into the expense accounts—I think I have made out a case for this particular example. I have stated above that no scaffolding is needed in the erection of this steeple, and this will be admitted when it is seen that a few planks placed across the horizontal braces inside will give all the support needed to handle the pipe sections; these last are light, except in the first course, and can easily be assembled by two men. The security, both moral and physical, given by the fact that they are in no danger enables the workmen to give all their attention to the job.

It is possibly necessary to say here to some who are not familiar with commercial iron pipe and its fittings, that this material can be had in all needed weights and sections for the work to be done, that is, loads per square foot of floor area, or strains per square inch. The fittings are not confined to those familiar in household plumbing, but may be had amply strong for any work, such as hydraulic fittings, where the strains are severe and abrupt. The sizes, too, are convenient for application to a wide range of subjects; from ⅛ inch in the bore (all pipe sizes are reckoned by the diameter of the hole through them, not usually by the outer diameter) to 20 inches bore, and from ¼ inch thickness of wall to ¾ inch, in extra and double-thick pipe, giving factors of safety of any ratio required.

It is proper to say that no attempt has been made to furnish a working drawing in the illustration of the steeple, for obvious reasons, but any architect or engineer can readily make one from the suggestions in this article. The design is on an approximate scale 1/20 inch to 12 inches but the limited space available for the example makes some of the members appear very frail.

The pipe lengths are 20 feet long in each section, and, respectively, 5-inch, double extra strong, (about ⅞ of one inch thick in the walls) 4½ inches, extra strong (.378 of one inch thick) 4-inch extra strong, and 3-inch standard pipe for the top course, all outside diameters and steel pipe. The cost of this at present list and discounts would be $450 more or less, by reason of the varying discount for less than one carload. The weight of the whole lot would be in round numbers a little over 5 tons for pipe and connections. This steel frame would rest upon the campanile and be bolted to the roof timbers in the usual way. The exterior sheathing and covering would be attached to the timber braces as shown, by brackets of cast iron slipped over each course of pipe as it is erected. These brackets rest upon the pipe-couplings and require no attachment to the pipes, for they cannot move up or down; the pipes are, therefore, free to expand or contract, as the weather compels. No holes are to be drilled in them.

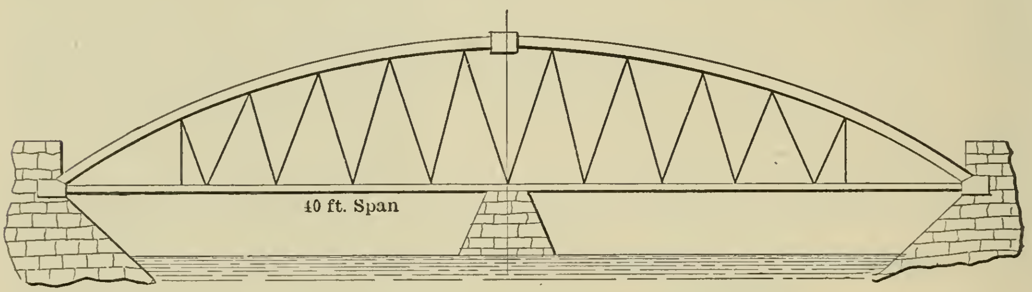


FIG. 4. BRIDGE SPAN BUILT OF STEEL PIPE.

Now compare this estimate with a timber frame and it will be seen that the steel construction is very much less. I consulted three builders of long experience in this class of work and they did not vary materially in their statements as to the cost of a wooden structure; this was $1,000 at the lowest estimate. While wood is of course much cheaper than steel it must be borne in mind that the labor account in the former is serious, both skilled and unskilled, while in the case of the pipe frame

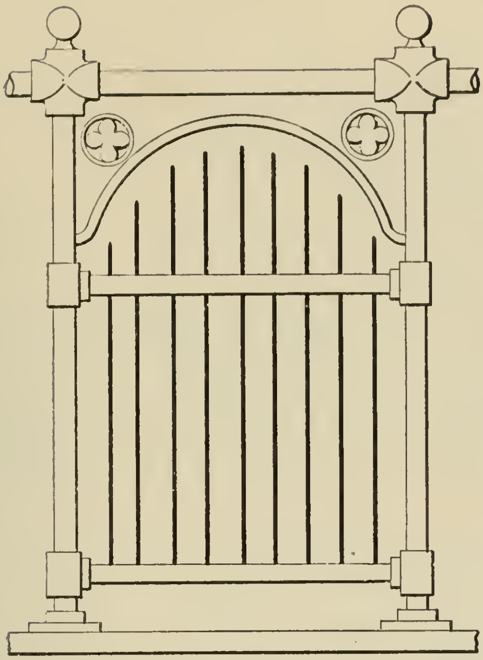


FIG. 5. DESIGN FOR IRON RAILING.

the material comes from the mill ready to erect, and the setting up is a small matter. I have said nothing about the exterior sheathing, slating, and scaffolding, but the latter is an expensive item in the wooden frame; the cost of the outside work would be the same in one case as the other, no matter whether steel or wood be employed.

Pipe construction is especially useful and available for highway bridges in sparsely settled sections where the township funds are small for such purposes. A single arch formed of two pipes of the proper size for the span and greatest probable load, or one pipe if the span is less than 20 feet, can be easily sprung over a creek or ravine without the services of engineers and bridge builders, and at a nominal cost. The anchorages are quite within the capacity of men of ordinary intelligence, and all the fittings can be bought in open market, leaving only their assemblage and the flooring to be dealt with. The sketch shows such a bridge for a span of 40 feet and a maximum load of 10 tons, which is much greater than the average country traffic requires. The margin of safety is nearly four times the working load. It should be readily erected by a village blacksmith, he supplying the suspender straps or radius bars for the floor also. The cost of this bridge exclusive of labor would be inside of $200 for material only.

If necessary for navigation the central pier can be omitted. 40 feet span is a pretty good length for a township bridge, and would be longer than is needed in most situations, but the use of pipe of the proper dimensions is possible and economical; the shorter the span the more readily it can be erected by unskilled labor.

The fence panel shown in Figure 5 is a suggestion for cemetery or other work where it is appropriate; it is all pipe and pipe-fittings with the exception of the casting at the top, which may be varied to suit the surroundings and nature of the structure it confines.

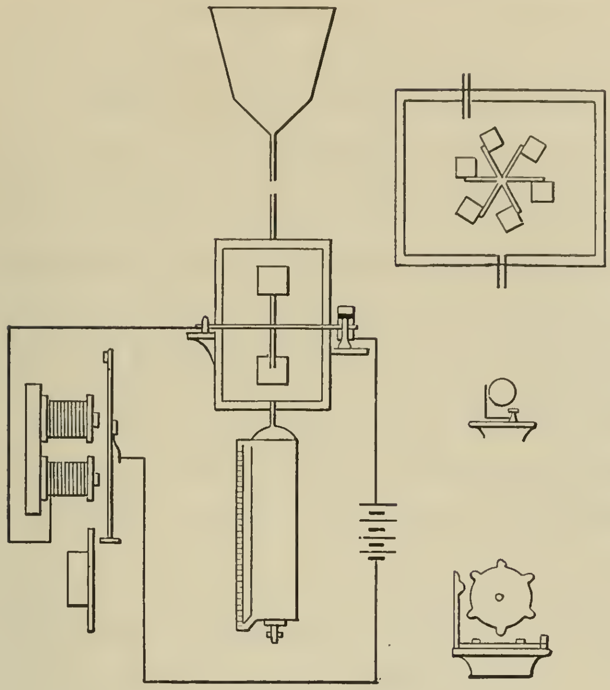
APPLICATIONS OF ELECTRICITY TO AGRICULTURE.

By Emile Guarini.

Reference was made in these pages not many months ago to the possibility that even agriculture might be brought under the direction and control of the engineer—in its routine, that is, as distinguished from special interventions. In the latter direction the irrigation engineer has been a beneficent providence to the agriculturist from time immemorial. M. Guarini makes an interesting showing of the advance which the electrical engineer is now making in the reduction of the ordinary operations of farming to a basis of scientific economy.—The Editors.

THE century just closed well merits the name given it—"the century of electricity." It was the nineteenth century which assisted in the discovery of the laws governing this elementary force and which saw the birth of the many marvellous inventions making electricity the daily servant, in every workshop and every industry, of perfection and economy in production. Agriculture alone, bound to its superannuated methods, seems to be an exception offering no welcome to this new auxiliary. I do not mean to say that no attempt whatever has been made in this direction, but that it is still extremely rarely that even large agricultural undertakings make any important use of electricity, while almost every workshop, however insignificant, has its electric installation, large or small.

This abstention on the part of agriculture is the more regrettable because the advantages which it thus fails to grasp are really great. It has been clearly shown, for example, that electricity, far from injuring vegetation as had been alleged, actually aids its development and under certain conditions exerts upon it an influence analogous to that of electro-therapy upon the human system. Beyond this, there are many applications of electricity to be made on the farm. It will be enough for the present to cite, as the most important: 1.—The lighting of the fields for night work, and the lighting of the farm house and its outbuildings. 2.—Telegraphic and telephonic communication between farms, minimising the disastrous effects of isolation in sparsely settled districts like certain parts of South America, the Congo, etc. 3.—The supply of a motive power highly



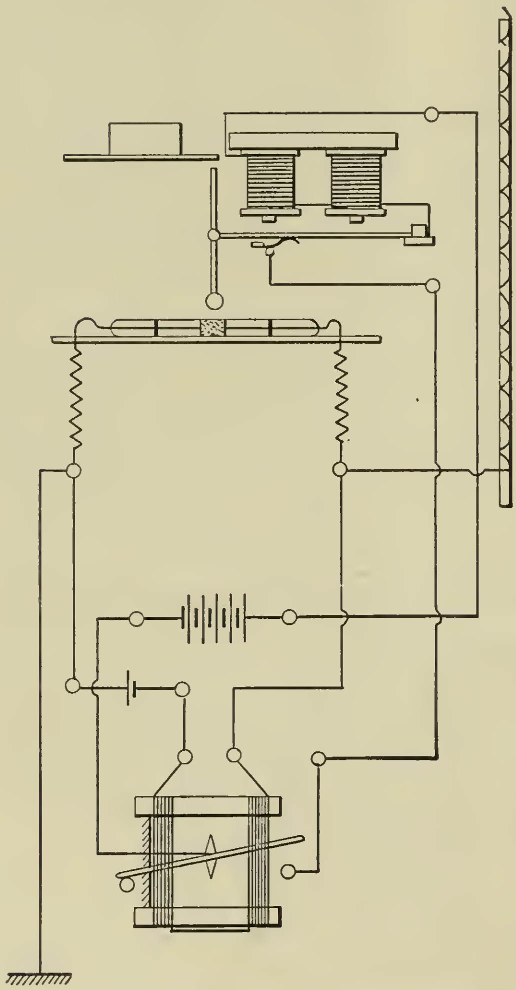
LANCETTA'S ELECTRIC RAIN GAUGE.

adapted to agriculture—that is to say, economical, divisible into small units, easy of transmission, and demanding little oversight.

Leaving aside with some regret, as outside the proper province of this Magazine, the interesting subject of the influence of electric currents and electric light upon the growth and quality of crops, and turning our attention to the more mechanical applications, we find so many that we must select again even from this list. Thus, for example, electricity may be applied to the aging of wine. But it has more important services than that to render to agriculture, as (among others) through the agency of two pieces of apparatus devised by the well-known Italian meteorologist, Lancetta—the "pluviometer" or rain gauge, and the electrograph. The former is designed to give the farmer most useful data of rainfall; the second, to indicate the progress of storms. The importance of this information to paragrandine stations is manifest. Exact observations of the local rainfall also, as everyone knows, are of the utmost value to agriculture, but the ordinary rain gauge is defective in that it does not give sufficiently precise indications of the *character* of the downfall. This point, however, is of prime import, because while fine and frequent rains keep the soil fresh and moist, a violent downpour carries away in the rush of its waters not only the seeds and growing plants. but even the fertile top soil; its effects are therefore almost wholly destructive. It is true that instruments existed which gave the needful information, but they were far too expensive. To overcome this drawback Professor Lancetta devised his registering rain gauge which is inexpensive, simple in construction, and entirely automatic in its acton.

This electric rain gauge is composed of four parts: 1.—The collecting receiver, which may be placed, for example, on the roof. 2.—The measuring apparatus, placed near to or far from the receiver as may be convenient—perhaps in the room with the rest of the apparatus. 3.—The graduated receiver. 4.—The registering device, placed as far as convenience may require from the other parts. A tube carries the water collected in the receiver to the measuring apparatus, consisting of a little water wheel (a sort of bucket wheel) on an axle one end of which is in frictional contact with a conducting wire forming part of the circuit, while the other end carries a toothed wheel which, as it turns, makes and breaks circuit with a contact connected with a battery and an electro-magnet whose armature carries a pencil. This pencil marks on a dial carrying the hours and turned by clockwork one revolution in twenty-four hours. The graduated receiver is directly under the metering device and communicates with it by a tube; a small glass graduate on the side of this receiver permits the height of the collected rain water to be read in figures reduced to millimetres of rainfall.

The wheel of the measuring apparatus consists of several small buckets so held by a spring that the wheel does not turn until the one of these buckets immediately under the funnel of the collector is entirely filled. As soon as this occurs, the spring yields, the wheel turns, one of the teeth of the circuit breaker carried on the end of the axle makes contact with a strip attached to the battery circuit, which is thus closed; the armature of the electro-magnet is attracted and the pencil marks on the dial. Each point thus marked corresponds to one millimetre of rainfall. The device therefore indicates the total fall and the time of its duration. It shows further the exact time of the commencement and cessation of the rain, the interruptions during the twenty-four hours, the duration of the maximum downfall and the rate at any time, since the faster the fall, the closer together will be



THE LANCETTA ELECTRIC STORM DETECTOR.

the points on the dial. These records permit the construction of charts invaluable to agriculture.

The second of Professor Lancetta's inventions relates to the detection of electric discharges in the atmosphere. His electrograph (Figure 7) consists of a coherer—connected on one side to the earth and on the other to an antenna—in circuit with a battery and the coil of a galvanometer. The galvanometer needle, as it turns, oscillates a small strip of platinum foil attached to it which closes the circuit of a battery and sounder. The armature of the sounder carries a pen or a pencil on one side and a hammer on the other. The registering device is completed by a dial marked with the hours, which is moved before the pencil by clockwork, making one complete revolution in twenty-four hours. When the coherer is affected by a lightning discharge, the galvanometer closes the sounder circuit. As the sounder armature is attracted, the pencil it carries marks upon the dial at every downward movement; at each interruption, as it is released, in its upward movement it strikes and de-coheres the tube of filings. By adding a second sounder, attention might be called immediately to the recording of any signal and the observer thus be put in position to follow from the outset the progress of a storm.

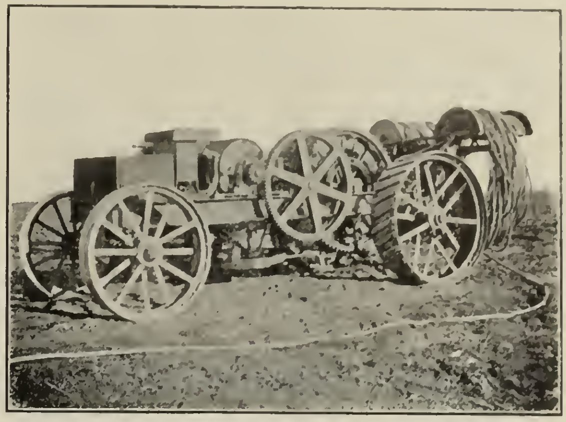
Strokes of the bell at comparatively long intervals would signify: "Storm in sight—probability of its coming." Strokes becoming increasingly more frequent would indicate: "The storm increases in intensity, or approaches; the probability of its coming increases." The progressive retardation of the signals after an acceleration would mean: "The storm diminishes, or grows more distant; the probability is that it will not reach the place of observation."

Coming now to the larger applications, the first to be considered is electric lighting. The benefits which it can confer in this field are most striking when one contemplates the possibility of replacing the dim and dangerous stable lantern or the smoky and odoriferous oil lamp by the brilliant and hygienic incandescent light which, everywhere adaptable, is controlled by simply touching a button and brings comfort and convenience with it. Elsewhere, again, arc lights may illuminate the yards, however large, and even light the fields for night work with a brilliancy and convenience unapproachable by any other method. The same generating plant which supplies power for operating the ploughs by day can—perhaps with the necessary assistance of accumulators—furnish the lighting by night.

But if, in spite of its manifest advantages, electric lighting has had very limited introduction on the farm, telephony and telegraphy, so far as my knowledge goes, are absolutely unused there. It may be because the advantages to be gained do not seem sufficiently important, or because there has not yet been offered apparatus simple enough and easy enough to manage to be placed in the hands of farmers, or because the installations are too costly, or simply because the people of the country are indisposed to progress. I am inclined rather to this last hypothesis, for the advantages they would derive from the use of methods of electric communication are strikingly apparent. Connection with market towns, for example, to cite no other, would give constant and prompt advices upon the course of prices and enable advantage to be taken of opportunities of sale or purchase. The proposition evidently applies only to large isolated farms or to detached hamlets where there is no telegraph or telephone office and sometimes not even a post office. The remaining question is whether the advantages to be gained would warrant the expense of the installation. The answer would naturally be the negative if an entire network of wires must be installed. This is the situation in which wireless telegraphy comes into play. For that no lines are needed, nothing but certain apparatus which may be large or small, costly or cheap, easy or difficult to manipulate, depending on the distance to be overcome. And telephony without wires—will not that supersede telegraphy? I am disposed to think so. Telephony requires no educated skill; it requires ability only to hear and to talk. There remains one difficulty—unfortunately a capital one—that wireless telephony is as yet making only its first steps, and those not very well assured. Preece and Gavey in England have, however, already succeeded in communicating at a distance of 7 kilometres, Collins in America at a mile, Maiche in France at 4 kilometres. A little more patience, and the solution will be found.

Of all applications of electricity to agriculture, by far the most important is unquestionably the adaptation of electric motors to the work of ploughing. Electric ploughs are operated under two systems—the single motor with anchor car, and the two-motor. For light homogeneous soils requiring only shallow working, the single-motor system is preferable on account of the moderate cost of installation and the ease of manipulation. For deep ploughing, however, with furrows of 36 centimetres (14 inches) or more in depth, and in rough ground, preference falls to the two-motor system.

The apparatus in the single-motor system is in three parts—the travelling electric motor, shown on the opposite page, which is placed on one side of the field, the anchor car, placed on the opposite side, and

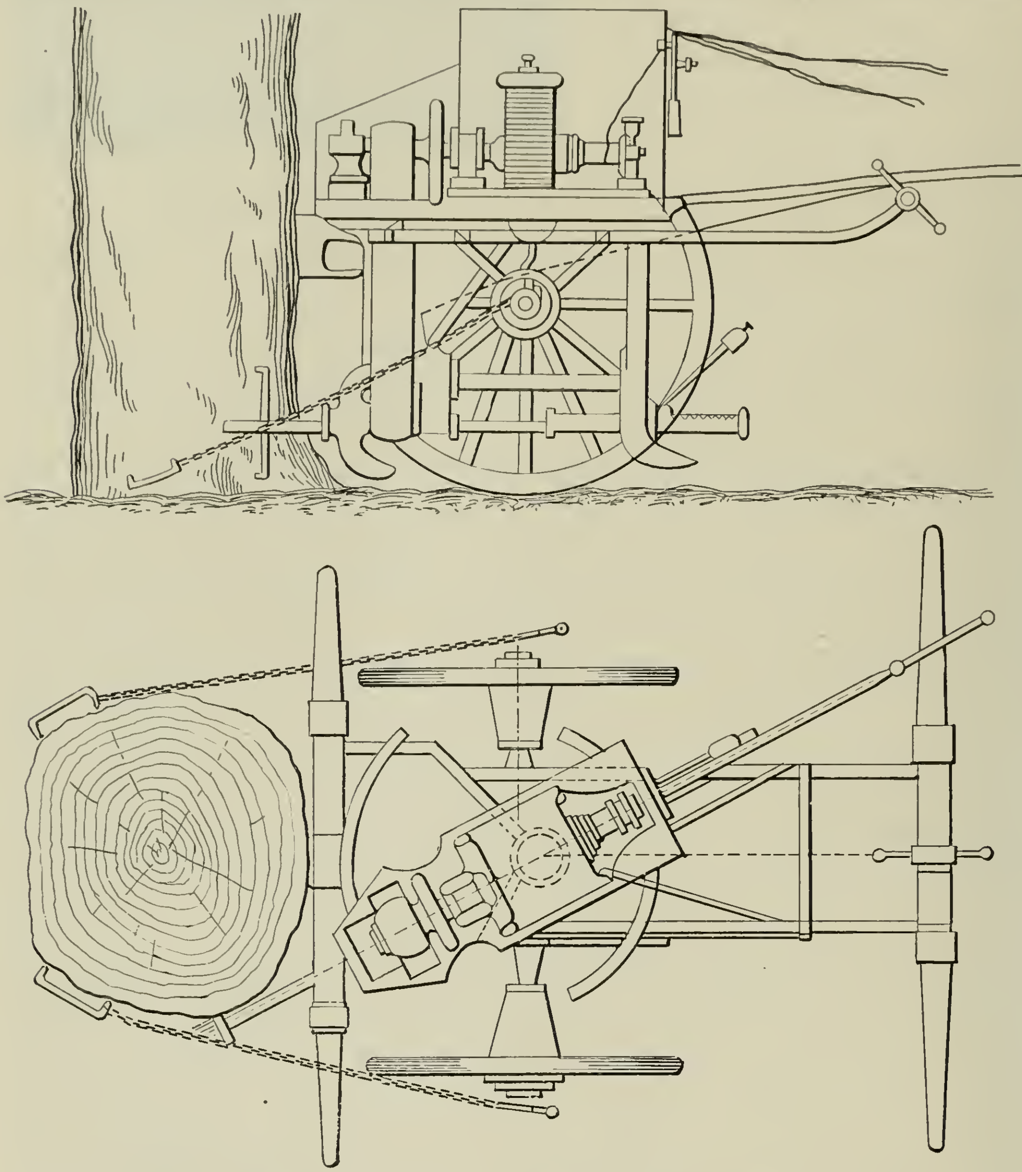


TRAVELLING ELECTRIC MOTOR, ELECTRIC PLOUGHING SYSTEM.

the rope transmitting the power. In the two-motor system the anchor car is replaced by a second motor; the motors operate alternately in moving the plough back and forth across the field. 60 horse power are requisite as a maximum for turning a 36-centimetre furrow in heavy soil. The travelling motors must of course be drawn by horse from the farm to the first point of contact with the electric cables.

In an installation recently put in by Magnin & Bureau the cost of ploughing 2,100 square metres—say a length of furrow of 2,400 metres—with four men, was 12 kilowatt hours. The area ploughed in a winter day was 1.6 hectares (4 acres); the depth of the furrows was 23 centimetres, the breadth 73 centimetres (9 inches by 29 inches); the resistance of the soil was 55 kilogrammes per square decimetre (1,130 pounds per square foot); the efficiency was 45.4 per cent. on an expenditure of about 30 horse power. In experiments by Félix Prat and Enguibaud, the efficiency was 43 per cent. and the cost 110 francs per hectare ($9.20 or £1 18 4 per acre); the installation cost 30,000 francs and would work about 1/3 of a hectare (about ¾ acre) a day with four men. It should be said at this point that the German agriculturist Brutschwe has calculated that 4 hectares could be ploughed to a depth of 35 centimetres in one day on 90 kilowatt hours. Taking the kilowatt at 0.29 francs (5.5 cents or 2.75 d) and counting in all expenses for wages, upkeep, interest, sinking fund, etc., the total cost of electric ploughing would be 25.89 francs per hectare ($2.09 or £0 8 8 per acre). A French authority on agriculture, M. Ringelmann, disputes these figures and asserts that the kilowatt hour should be taken at 0.36 franc, bringing the cost up to 38.62 francs per hectare ($2.32 or £0 9 8 per acre). Further, if the area ploughed be increased to 6 hectares a day instead of 4, the cost will fall, according to Ringelmann, to 25.75 francs per hectare. Agriculturists are in accord in putting the efficiency of the steam plough at only 25 per cent., and that of the electric plough at 50 per cent.

Other uses of electromotors in agriculture are for running various machines, such as those for cutting straw, hay, carrots, or for breaking up oil cake, threshing wheat, etc. Another curious machine meriting notice (see below) is one invented and built by Ganz for the felling of trees. It is said to be much used in the forests of Galicia The machine carries an electric motor on a platform supported on a pair of wheels. By means of a belt, the pulley of the motor drives a routing tool supported on the lower part of the apparatus, levers

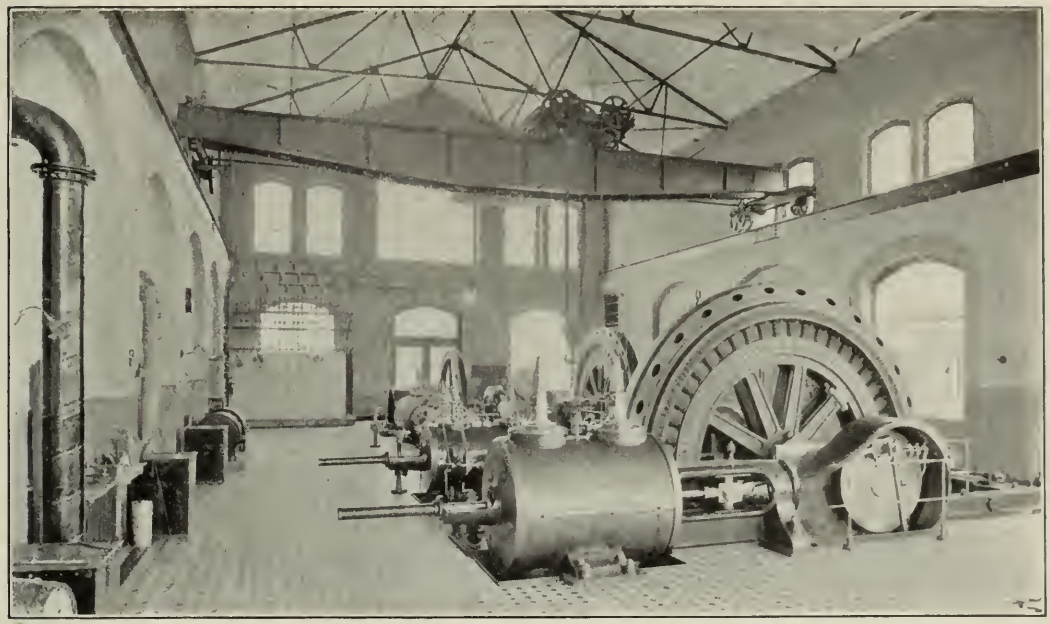


ELECTRIC APPLIANCE FOR FELLING TIMBER. ELEVATION AND PLAN.

serving to swing both motor and boring tool. In use, the machine is brought up against the tree, the motor is started, and the router is swept radially across the tree trunk as it cuts its way in. In this way the tree is very quickly felled.

In Algeria also are found some ingenious applications of electricity to agricultural work. It is there in practical use for driving a sort of collector which picks up the grapes from the ground and carries them to the press, for the traction of the ploughs used in cultivating the vineyards, and for operating cars, elevators, pumps, etc.

Notwithstanding the manifest advantages of these various appliances, electrically equipped farms are so far few. This is to be explained partly by the conservatism with which the farming class generally hold to the institutions of their fathers, and partly by the



ELECTRIC CENTRAL STATION, CROTTORF AGRICULTURAL INSTALLATION.

fact that to be really practical and economical, an agricultural electric installation requires the association of a number of farmers. And it may be remarked, by the way, that in farming districts the spirit of association is hardly more than embryonic. Indeed, for a farm to have an electric installation at its sole disposition, it is practically requisite for it to combine with the farming some collateral industry, such as a creamery or a brewery—a thing necessitating considerable capital. Under these conditions, however, the turbines or engines which supply power for the auxiliary industry may with advantage operate the dynamos for the agricultural power applications

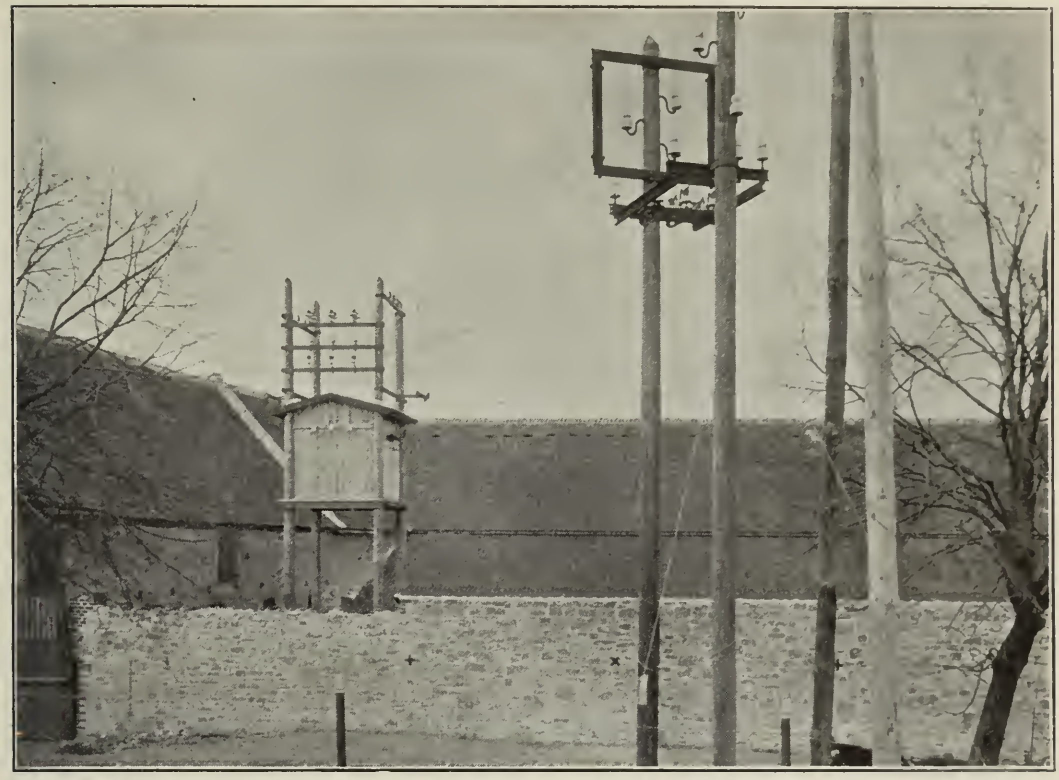
It may be interesting to examine a concrete example of an electrically operated farm, and for that we may take the installation lately provided by the Société Helios, of Cologne, for Crottorf, Saxony. The plant is especially interesting because it is designed to serve a number of farms simultaneously.

Crottorf, on the Magdeburg-Halberstadt railway, is in the centre of the district of Aschersleben. Its wide fertile fields, its extended culture of beets, and its sugar factories, give a characteristic appearance to a region sown with many small villages. The power supplied by the river Bode first suggested the idea of the electric plants we are about to consider. Not far from Crottorf the Bode makes a great curve, cut across by a canal; here was once a mill, and on its site stands now the electric central station.

The maximum of power obtainable from the river is 500 horse power. The demands for lighting and motive power in the vicinity and on the neighbouring farms were, however, largely in excess of this, and account must be taken also of the fact that in times of low water level in the river the hydraulic power available would be much smaller. It could serve only as a reserve to the main source, which

HORDORF SUB-STATION, CROTTORF AGRICULTURAL ELECTRIC INSTALLATION.

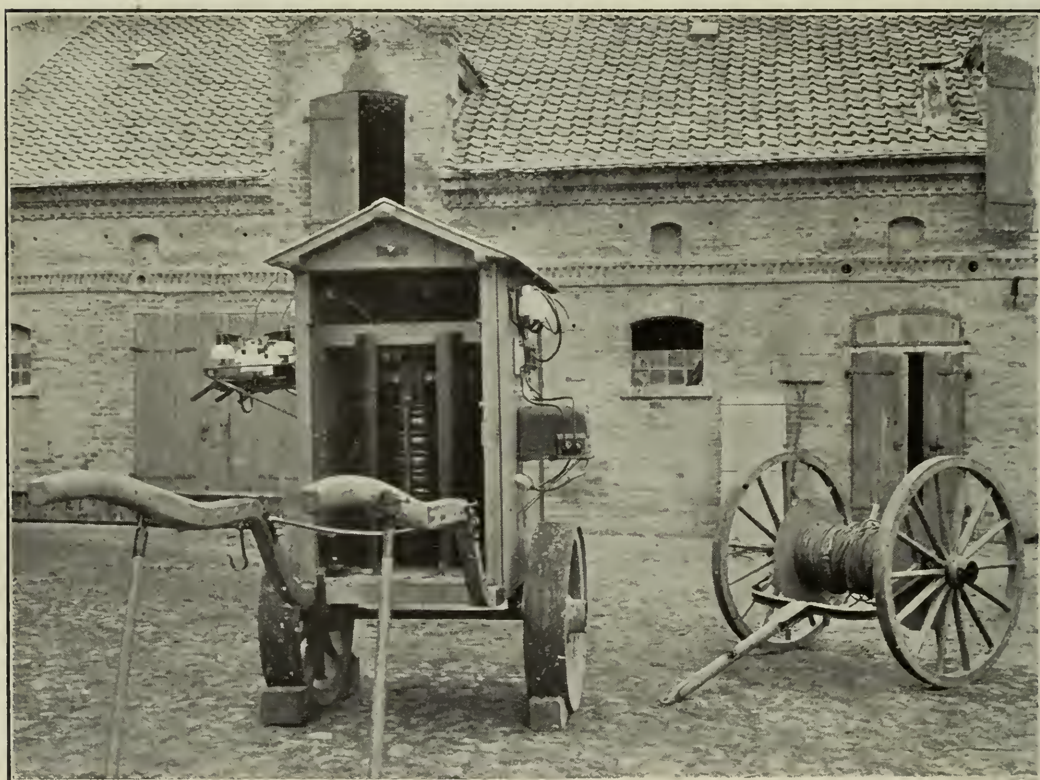
must be otherwise assured. The presence of a large colliery in the vicinity provided the means of securing the necessary supply at a moderate cost. For electric transformation of the water power, three turbines were installed; with a fall of 2.7 metres and a volume of 6.45 cubic metres a second, each of these develops 185 horse power at



TRANSFORMER HOUSE RAISED ON POLES, CROTTORF.

54 revolutions a minute. All are geared to one shaft, direct-connected to a generator which may also be driven by a steam engine. A second dynamo is installed, driven only by steam. When the river is neither too high nor too low, the turbines can be depended on for a mean of 350 horse power, with a maximum of 500. When the water is insufficient, or when the turbines can not operate, the engine is called upon for a part or all of the needed power. The auxiliary engine coupled to the same dynamo as the turbines is a horizontal compound of 250 brake horse power (metric); the engine connected to the second generator is of 500 horse power. The building housing the plant is large enough to permit the installation of two more units of the same size. Up to the present it is limited to two 500-kilowatt fly-wheel generators of alternating type supplied by the Helios Company; they make 125 revolutions and deliver current at 7,000 volts.

THRESHING MACHINE DRIVEN BY PORTABLE ELECTRIC MOTOR, AT CROTTORF.



PORTABLE TRANSFORMER OF THE CROTTORF INSTALLATION.

The next consideration was the distribution of the high-tension current to the seven districts within a radius of 30 kilometres in which large sales of electricity for lighting and power purposes were expected. The best plan was determined to be in the establishment, in each of these places, of a central secondary transforming station transforming current for both light and power uses. However, where very large demands for lighting current were anticipated, it was thought expedient to separate the lighting and power circuits. It was necessary also to provide for the requirements of threshing machines, the demands of which are sometimes large and sometimes small, but always very irregular. To use the central generators at their full capacity during the day and to employ small apparatus most in proportion to the total ordinary consumption, the large central secondary stations are furnished with accumulator batteries charged by rotaries converting alternating current to direct.

Thanks to the complete separation of the lighting and power circuits, the absolute steadiness of the lights is assured while at the same time all danger from high-tension current on the lighting circuit is avoided. The smaller sub-stations contain static transformers and are housed in with sheet iron.

Efforts have been made at Crottorf to promote the introduction of electric power into farm work, principally the threshing of wheat. The motor is mounted on a vehicle—an arrangement which facilitates bringing the motor near to the machines it is to operate. To permit the attachment of a motor in the fields directly to the high-tension cables, there has been devised a portable transformer which can be attached to the primary circuit by high-tension cables.

The extension of the use of electricity in agriculture depends upon several factors, of which the most important seem to be: 1.—The removal of the repugnance to change manifested by the average farmer; this must be accomplished by education and example, in which Governments and large landed proprietors may be very helpful. 2.—The growth of a spirit of co-operation and association among agriculturists, as thus only could a central station be made economical, or even possible. 3.—The development of auxiliary industries, enabling an electric installation to be operated to greater profit. 4.—The establishment of transportation and communication lines between the many small farms. By these means the use of electricity might be popularised. It is not a consummation to be expected today or tomorrow, but the past is prophecy of the future. Applied science seems capable of all things, and its progress is everywhere tireless.

LIQUID FUEL FOR POWER PURPOSES.

By Arthur L. Williston.

IN a previous article in the May number of THE ENGINEERING MAGAZINE, the use of crude oil or petroleum as a combustible under steam boilers was discussed in some of its mechanical aspects. The efficiency of the liquid-fuel combustion was there shown to depend largely on the character and the design of the furnace used; several typical oil burners of the different types in common use also were described—the successful operation of each depending, it appeared, on the thoroughness with which it atomizes the oil. It was found that in order to obtain the best results and always to secure complete combustion, the oil must be finely sprayed against the incandescent surface of the fire-brick furnace lining or arches, and that small quantities of heated air should be admitted to the furnace at as many points as possible, so as to insure that all of the minute particles of fuel shall come in contact with the quantity of air needed for their perfect combustion, at a point in the furnace where the temperature is sufficiently high to make ignition certain.

In the present article, it is my purpose to discuss oil burning on its economic side, and—as far as possible—to answer the questions: *When does it pay to use oil as a substitute for coal?* and, *What saving in annual expenditure can be expected by such a substitution?*

The great objection to the use of petroleum as the universal fuel is the limited quantity of it available for such use today as compared with the supply of coal, which is practically unlimited, at least for several centuries. The total output of petroleum in the United States for the year 1901 was 69,389,000 barrels—a quantity sufficient to develop more than 3,000,000 horse power during ten hours each day for 365 days in the year. Impressive as these figures are, however, it must be remembered that the greater part of the annual supply of petroleum is, as we shall see later, more valuable for illuminating and lubricating oils than for fuel, and consequently, that no large fraction of the total annual production can, at any time, be consumed as fuel. Nevertheless, the rapid growth in the use of petroleum for fuel during the past two years—especially under stationary boilers in the western and southwestern parts of the United States, and for motive power on the railroads over a much wider area, including nearly all the western States and parts of several of the Gulf States—shows definitely that such a use of oil *does pay* under favorable conditions. The variation in the prices of fuel oil and steam coal in different localities makes it impossible to say when these favorable conditions exist, under which a saving can be effected by the substitution of oil for coal, or what the extent of such saving will be, without working out the problem in considerable detail for each set of circumstances in each locality, basing all calculations on the current local market quotations.

In such calculations of the comparative economy of liquid fuel and coal, two distinct ways will appear in which oil burning may show a saving.

1. Liquid fuel because of its *direct* influence on the annual charges for *fuel, firing,* and *repairs,* may reduce the operating expenses.

2. Liquid fuel because of its *indirect* influence—by so altering the design of the power plant as to reduce its initial cost, when planned to develop a given horse power—may reduce the annual fixed charges for *interest, taxes,* and *depreciation.* Or it may increase the power which is available in the existing plant, thus making additions to its capacity, otherwise needed, unnecessary, which is, of course, practically the same thing so far as its influence on economy is concerned.

The first of these aspects is the particular theme of the present article. The second will be discussed in a following paper in the August issue of this Magazine.

These two possible sources of economy I shall discuss separately, because, in those parts of the United States where the price of oil so nearly equals the relative price of coal that the slight fluctuations which are always likely to take place in the price of either fuel, would make oil burning no longer profitable, it would be necessary to regard the oil installation as of temporary character. In such cases it is proper for us to consider only the first of these two sources of saving; while in states such as Texas and California, where we have every reason to believe that there is an assured supply of oil for power purposes for many years to come, and where, therefore, the oil-burning plant may be regarded in the nature of a permanent installation, we may properly consider both of these sources of economy which I have just mentioned.

The physical properties of the oils used as fuel in the United

States differ widely, but their heating values when burned under steam boilers may usually be taken as a constant quantity for all practical purposes. There is almost no variation in this respect in the crude petroleums from the different wells of the same field, and the difference in the calorific value of the crude Pennsylvania and the crude Texas oils—the two oils that differ perhaps the most in other respects—is very slight. The heating value of crude petroleum will also vary slightly from that of the so-called "reduced" oil, from which the lighter and more volatile oils, such as naphtha and kerosene, have been distilled. It happens, however, that all of the hydro-carbons which are found in the crude petroleums, while differing greatly in specific gravity and in volatility, have carbon and hydrogen present in very nearly constant ratio, consequently the calorific value is practically the same for them all. Thus one sample of Beaumont crude oil gives:

Carbon	84.6 per cent.
Hydrogen	10.9 " "
Sulphur	1.6 " "
Oxygen	2.9 " "

Calorific value per pound, by De Long's formula, 19,060 B. T. U.

An analysis of the reduced oil from the same field from which many of the lighter hydro-carbons have been removed shows:

Carbon	83.3 per cent.
Hydrogen	12.4 " "
Sulphur	.5 " "
Oxygen	3.8 " "

Calorific value per pound, by De Long's formula, 19,481 B. T. U.

The reduced oil appears from these two samples to have a heating power about 2 per cent. greater than the crude oil, when compared pound for pound. The reduced oil at the same price per gallon, however, has a greater advantage over the other from which the lighter oils have not been removed, because it has a higher specific gravity, and there are therefore, with it, more pounds to each gallon. The heavier oil has the additional advantage, too, of being safer in storage and in transportation, as at ordinary temperatures it does not give off gases which might form an explosive mixture with the air.

TABLE I.

	Beaumont, Texas, No. 1.	Beaumont, Texas, No. 2.	Pennsylvania.	Lima, Ohio.	Russia.
Carbon	84.60	85.03	86.10	85.00	86.60
Hydrogen	10.90	12.30	13.90	13.80	12.30
Sulphur	1.63	1.75	.06	.60	.00
Oxygen and nitrogen	2.87	6.00	.00	.60	1.10
Calorific value per pound in B. T. U.	19,060	19,388	202,000	20,060	19,500
Theoretical evaporation from and at 212° per pound	19.7	20.1	20.9	20.7	20.2

Table No. 1 gives the analyses and calculated heating values and theoretical evaporation of five samples of petroleum—two of them from Texas and the remainder from Pennsylvania, Ohio, and Russia. For purposes of general calculation, we may assume any one of the above figures for the calorific value of oil as sufficiently accurate; or for approximate calculations, one pound of either crude oil or reduced oil from any field may be considered as having a heating value equal to 20,000 British thermal units per pound. All of this heat cannot be utilized under the boiler; some of it will be lost by radiation, and a larger quantity will of necessity escape up the stack wih the products of combustion.

If the maximum temperature in the furnace is 2,300 degrees Fahrenheit, and 560 degrees Fahrenheit is the temperature of the escaping gases at the base of the stack, and 60 degrees Fahrenheit that of the atmosphere, then the maximum possible efficiency of the furnace will be:

$$\frac{2300-560}{2300-60} = 77.6 \text{ per cent.}$$

Allowing 3 per cent. for radiation losses, there remains practically 75 per cent. as the highest attainable efficiency. If, however, by accurate adjustment of the air supply the maximum temperature of the fire were increased to 2,400 degrees Fahrenheit, and by the use of the economizers or additional heating surface the stack temperature were reduced to 400 degrees Fahrenheit, then the maximum possible efficiency would be:

$$\frac{2400-400}{2400-60} = 85.5 \text{ per cent.}$$

Allowing 3 per cent. radiation this would leave an efficiency of 82.5 per cent. It is doubtful if this efficiency is often, if ever, reached. It shows approximately the limit of the possibilities. 78 per cent. has been reached frequently under favorable circumstances, but from 74 to 76 per cent. is probably a more common efficiency in daily practice. Assuming a calorific value for liquid fuel half way between that of the two samples of Texas oil given above, or 19,224 British thermal units, and assuming an efficiency of 78 per cent. for the furnace and boiler, an evaporation of 15.5 pounds of water from and at 212 degrees per pound of fuel is possible. A more probable figure for daily commercial practice, however, is 15 pounds of water evaporated per pound of fuel.

The heating value of a pound of coal is a variable quantity depending on the kind of coal and on the per cent. of ash that it contains—varying between much wider limits than the corresponding value for the oils that we have been considering. A sample of Pocahontas coal (run of mine) gives the following analysis and calculated heating value:

Carbon	82.26
Hydrogen	3.89
Oxygen	4.12
Nitrogen	.64
Sulphur	.49
Ash	8.60
Calorific value per pound of coal	14,067 B. T. U.
Calorific value per pound of combustible	15,390 B. T. U.

This is a high heating value for a steam coal. The calorific value of other coals will vary, as we shall see later, all the way from this figure to about 9,500 or 10,000 British thermal units per pound according to the coal, the latter figures being average values for western lignite.

In figuring the comparative economy of the two kinds of fuel which we are considering, it is not sufficient to consider their relative heating values alone; it is necessary also to include in the calculations the probable efficiency that may be attained in combustion in commercial practice with each. With the best steam coals it is never possible to get as high an efficiency as is obtained with oil, because a certain percentage of the coal always escapes unconsumed through the grate bars with the ashes, and because, especially with hand firing, the air supply cannot be regulated so nicely with coal as with the liquid fuel. The poorer the quality of the coal, the greater the losses from these two causes will be. Thus with the best steam coals from 68 to 73 per cent. of the theoretical heating power of the fuel is all that may be utilized by the boiler, and it is more difficult to obtain this efficiency with coal than it is to obtain an efficiency 5 or 6 per cent. higher with liquid fuel. 68 per cent. for the boiler efficiency is therefore as high a figure as it is safe to count on in regular service, when good coal is burned; with many bituminous coals 60 to 62 per cent. is a good average efficiency; and with the poorer western coals and lignites, it is difficult to get an efficiency of more than 48 to 55 per cent.

Table II gives the heating power, commercial efficiency, evaporation, and relative value of Texas petroleum and of six different coals with which it is likely to come into competition in different places, for marine, locomotive, or stationary-boiler practice. The figures given in the last column of the table show how much the relative value of different coals varies when compared with oil. One pound of Texas oil is equivalent to 1.5 pounds of Pocahontas coal or to 3 pounds of lignite.

TABLE II.

Fuel.	Calorific value per pound of coal, B.T.U.	Probable efficiency, per cent.	Commercial evaporation from and at 212° : pounds.	Relative fuel value.
Petroleum (Texas)	19,224	75	15.0	1.00
Pocahontas Coal (run of mine)..	14,067	68	10.0	.66
Anthracite Buckwheat, No. 1.....	13,250	68	8.7	.58
Pittsburg Bituminous	13,060	66	8.5	.56
Indiana Block	12,540	62	7.5	.50
New Mexico and Indian Territory Bituminous	11,300	55	6.0	.40
Western Lignite	96,500	50	5.0	.33

The figure opposite petroleum in the third column of the table gives the total evaporation from and at 212 degrees Fahrenheit without deducting anything for the steam used to atomize the oil. If an allowance be made for this, the evaporation instead of being 15 pounds would probably not exceed 14⅜ or 14½ pounds of steam per pound of oil. This evaporation, it is true, is higher than is attained on an average in the power plants where liquid fuel has been used. It represents an efficiency that ought to be reached, day in and day out, in well designed plants that are properly cared for. The other figures in the same column of Table No. II are, however, based on the same conditions; consequently comparison between them will be fair and may be applied to all plants, whether economically run or not, so long as the same degree of care is exercised when oil is used as has been exercised with coal.

TABLE III.

Tests.	Quality of Oil.	Evaporation from and at 212°, pounds.	Efficiency, per cent.
U. S. Navy Experiments......	21,000 B. T. U........	16.9	77.8
Tests made by Engineers' Club of Philadelphia	....	16.48	....
Tests reported by Prof. Denton	Beaumont Oil, 19,060 B. T. U..........	15.49	78.5
Tests at New Orleans	Texas Oil............	15.30	77.5
Tests reported in Journal of Franklin Institute	W. Virginia Oil, 20,960 B. T. U..........	16.50	76.0
Tests reported in Journal of Franklin Institute	Texas, Oil, 18,850 B. T. U............	15.16	76.8
Tests reported by Liquid Fuel Board of U. S. Navy......	Reduced Beaumont Oil, 19,480 B. T. U....	14.43	71.5

NOTE.—The evaporation given in the last test made by the Liquid Fuel Board of the U. S. Navy was obtained when the boilers were being forced to a point which gave but 6.5 square feet of heating surface for each boiler horse power developed.

Table III gives the evaporation and efficiency results of a few of the tests that have been reported in the technical press, and from them it will appear that the figures assumed for the commercial evaporation with Texas petroleum are not unduly high.

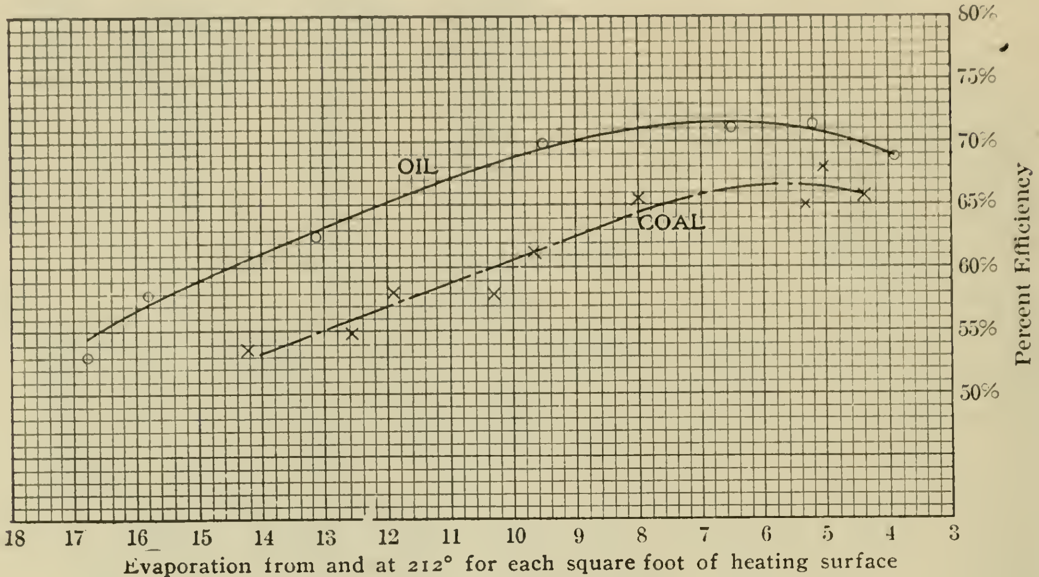


FIG. I. CURVES SHOWING THE RELATION BETWEEN BOILER EFFICIENCY AND RATE OF EVAPORATION FOR TEXAS OIL AND POCAHONTAS COAL. PLOTTED FROM TESTS REPORTED BY THE LIQUID FUEL BOARD OF THE UNITED STATES NAVY.

In Figure 1 are plotted the results of some of the tests made by the Liquid Fuel Board of the United States Navy showing the efficiency in terms of the evaporation per square foot of heating surface per hour for both oil and coal. These curves bring out clearly several points that are of interest. (1) The oil shows an efficiency of about 5 per cent. greater than the coal for the same rate of evaporation. (2) The oil gives an evaporation, or capacity to the boiler, from 15 to 50 per cent. greater than the coal for the same efficiency. (3) The boiler could be forced with the liquid fuel to an evaporation equivalent to a rate of combustion of coal of 85 pounds per square foot of grate surface, or to a point where there was but 2.2 square feet of heating surface for each boiler horse power developed; this is 18 per cent. beyond the point to which the boiler could be fired with Pocahontas coal. (4) The oil showed an efficiency of 65 per cent. when the evaporation was equivalent to a rate of combustion of 56 pounds of coal per square foot of grate surface, or when there was but 3.1 square feet of heating surface to each boiler horse power developed. (5) The maximum efficiency with the oil was attained at a higher rate of evaporation than was the maximum efficiency of the coal. These results are not exceptional and other tests confirm the conclusions drawn from them. I have selected them for illustration only because they cover a wider range than any other published tests. In the tests reported by Professor Denton, referred to in Table III, an efficiency of 78.5 per cent. and an evaporation of 3.74 pound per square foot of heating surface was reached with oil, as compared with 71.4 per cent. efficiency and an evaporation of 2.22 pounds per square foot of heating surface with anthracite coal—a gain of 7.1 per cent in efficiency and 68 per cent. in capacity in favor of the oil. It is safe to count on a substantial gain in both of these directions when liquid fuel is used.

One barrel of oil contains 42 gallons, and each gallon weighs from 7.40 pounds to 7.90 pounds, according to the specific gravity of the oil. Texas oil weighs 7.66 pounds per gallon, therefore one barrel of it equals 322 pounds and, from the figures given in the last column of Table II, is equivalent for boiler purposes to the following:

483 pounds of Pocahontas coal,
555 pounds of Anthracite buckwheat coal,
575 pounds of Pittsburg bituminous coal,
644 pounds of Indiana block coal,
805 pounds of New Mexico and Indian Territory bituminous coal,
966 pounds of Western lignite.

Or reducing these figures to their equivalent in barrels of Texas oil for one ton of 2,000 pounds of each of the above coals:

One ton of 2,000 pounds Pocahontas coal	= 4.1 barrels Texas oil.
One ton of 2,000 pounds Anthracite buckwheat	= 3.6 barrels Texas oil.
One ton of 2,000 pounds Pittsburg bituminous coal	= 3.5 barrels Texas oil.
One ton of 2,000 pounds Indiana block coal	= 3.1 barrels Texas oil.
One ton of 2,000 pounds New Mexico or Indian Territory bituminous coal	= 2.5 barrels Texas oil.
One ton of 2,000 pounds Western lignite	= 2.1 barrels Texas oil.

From this comparison it is a very simple matter for us to ascertain the total cost for fuel for a steam plant in any locality from the market quotations on either petroleum or such steam coal as is available. But this is not the only item that needs to be taken into consideration in an exact analysis of the comparative economy of coal and liquid fuel. Three other items—the cost of firing, the cost of removal of ashes, and the probable cost of cleaning and keeping in repair the boilers and settings—must also be included.

First, the difference of cost in firing between the two kinds of fuel will depend on the size of the power plant. In very large power plants employing a large force of firemen, experience has shown that one man can tend a large number of oil burners, and that the same man who is employed as a water tender to be responsible for the water levels in the boilers, can also tend the oil burners of the boilers for which he is responsible. In such plants it is necessary to employ only enough additional men to keep the boiler room clean and to attend to the cleaning of the boilers and to assist in such repairs of boilers and settings as are necessary from time to time. In such a plant, where hand firing has been employed, oil burning will reduce the cost for firing and handling of fuel by at least 75 per cent. In a smaller plant the percentage of economy will not be so great. Thus, in one large establishment on the Pacific Coast where twenty-six firemen, in three shifts, were formerly employed, twelve men are needed since oil has been introduced—a reduction of 54 per cent. On the other hand, in a plant employing only one or two firemen, it would probably be impossible to make any saving whatsoever on this score, because it is always necessary to have at least one man on watch. For the same reason, there is no reduction in the cost of firing when oil is used on a locomotive, although the labors of the fireman are very much decreased, for it would never be safe to run a locomotive in regular service with only one man in the cab.

In order that we may judge how much the reduced cost in firing may effect the total cost, let us make a simple calculation for a steam plant of twenty boilers of 200 horse power each, a total of 4,000 horse power. Such a plant would require three shifts of eight firemen each and two men in charge as water tenders, a total of twenty-six men, at an average cost of about $2.00 per day. The total cost for firing would, therefore, be $54 per day, and the cost per ton of coal for firing would vary according to the quantity of the coal used to develop 4,000 horse power, from 28 cents to 40 cents. As we have already seen, in a plant of this size, there may be a reduction of the boiler-room force of from 55 per cent. to 60 per cent. if oil burning is introduced. This would be equivalent to a reduction of from 16 cents to 24 cents per ton of coal fired.

Second, the cost of removal of ashes will depend on the quality of coal which is used, some coals producing a very much larger amount of ashes to be handled than others. But, as this is a small item, we may properly take an average figure and assume that every 10 tons of coal burned will produce 5 cart loads of ashes that must be removed from the boiler room, carted away, and dumped. This will require extra service besides the regular force in the boiler room and the cost of it will vary according to the particular conditions surrounding each plant, from about 20 cents per load to probably 50 cents per load, according to the distance which the ashes have to be carted and the scale upon which the work is done. The removal of ashes, therefore, is equivalent to an amount of from 10 cents to 25 cents added to the cost of each ton of coal. But, for the purpose of a general estimate, we may take the average of these two figures and assume that the removal of ashes will be equal to an increase in the price of coal of 17½ cents per ton.

Third, it is very difficult to make an exact estimate of the difference in the cost of cleaning the boilers and maintaining them and their settings in a proper condition of repair, and yet there is no question but what the change from coal to the use of liquid fuel will materially affect all of these items on the balance sheet. With the use of oil, it is possible to maintain in the furnace and throughout the entire boiler setting a combustion so absolutely free from smoke and ashes and so much more nearly perfect than is possible with the use of coal, that the labor of keeping the tubes and the boiler clean will be materially lessened. This will result in a slight saving, but there will, undoubtedly, be a greater saving with the use of oil because of the decreased cost in the repairs of the boiler. There is absolute freedom, when burning oil, from the draughts of cold air which enter the furnace of the ordinary hand-fired boiler every time the fire-door is opened, and which cause temperature strains that tend to produce leaks in the riveted joints and around the tubes in the tube sheet, and that are unquestionably detrimental to the life of the boiler. The saving in repairs from the increased life of the boiler, caused by the freedom from such strains, we cannot exactly estimate in advance, but there is no question but that, in the long run, it will be found to exist. It will be greater in the case of internally fired boilers than with the ordinary multitubular and water-tube boilers, and greater still in the case of locomotive boilers where repairs to the fire-box are always a serious matter. In one plant with which I am familiar, where oil was used continuously for eight years, not a cent has been spent for repairs to any of the boilers and not a sign of a leak or deterioration has appeared—and this is the usual experience where oil has been used for any length of time. The effect of the oil burning on the boiler settings is, however, different. A greater allowance for annual repairs will be needed when oil is used for fuel in place of coal. There are two reasons for this. In the first place, with the oil there is a smaller percentage of the total heat absorbed by direct radiation from the fire to the boiler and, therefore, the average temperature of the furnace and settings throughout their entire length is higher. This causes a greater total expansion and contraction in the lining of the setting to which the brick work accommodates itself with difficulty. In the second place, the oil is forced into the boiler at high velocity by air or steam pressure, creating a constant vibration in the flame which is sufficient to cause a continual jarring or trembling in the brick work. In the course of time this jarring, together with the expansion caused by the intense heat in the lining, causes cracks in the settings, which, therefore, have to be repaired more frequently than when coal is used as the fuel. The experience of one large plant in this particular may be taken as a fair average of what may be expected. Over a period of years, the repairs to each setting amounted to between $140 and $150 a year. This is almost exactly double what had been paid annually for the same purpose when coal was employed as the fuel. A portion of this increased cost for repairs to the settings is balanced by the decreased cost in repairs to boilers, but I think it proper to allow at least $50 per year for each 200-horse-power boiler in which oil is burned, for the net increase in operating expense under this third heading. Dividing this amount by the number of tons of coal that were needed per year for each 200-horse-power boiler, in order to make the comparison between the cost of coal and oil, it is found to be equivalent to a saving of 5 cents per ton in favor of the coal.

To offset partially the cost of firing with coal, should be charged the expenditure of steam which is necessary to atomize the oil. The amount of this will depend upon whether air or steam is used, the pressure of the atomizing agent, and the efficiency of the burner, but it will generally be found to require from 2 per cent. to 4 per cent. of the total steam generated to operate the air compressor or to feed the burners. In some of the tests reported by the Liquid Fuel Board of the United States Navy, less than 2 per cent. of the total steam was required for atomizing. Tests on the Southern Pacific Railway give from 3.4 per cent. to 3.8 per cent. Other tests which have been reported show about the same amounts. In making accurate comparisons between the cost of coal and liquid fuel, this must be taken into account. In order to make comparisons readily the cost of this atomizing agent should be reduced to the same basis as the cost of firing coal, i. e., the cost per ton of coal burned. If this is done it will be found to equal a saving from 8 cents to 20 cents per ton in favor of the coal.

Summary.—In order to make this comparison more clear, and to show the way in which each of the items that I have discussed affects the final results, let us make the comparison, first, for a large power plant in New York city with anthracite buckwheat coal at $2.85 per ton of 2,000 pounds in the coal pocket, and reduced oil at 3½ cents per gallon delivered; and second, for a similar plant in California, New Orleans or in Texas with inferior coal at $5.25 per ton in the coal pocket and oil at 55 cents per barrel, delivered.

First: NEW YORK CITY.

Coal.		*Oil Burning.*	
1 ton of coal	$2.85	3.6 barrels of oil at $1.47	$5.29
Firing coal, per ton	.20	Steam for burners	.14
Removal of ashes	.18	Additional repairs	.05
	$3.23		$5.48

Increase in cost with oil burning, 69 per cent.

Second: CALIFORNIA, NEW ORLEANS, AND TEXAS.

Coal.		*Oil.*	
1 ton of coal	$5.25	2.55 barrels of oil at 55 cents	$1.40
Firing coal, per ton	.20	Steam for burners	.14
Removal of ashes	.18	Additional repairs	.05
	$5.63		$1.59

Saving in cost with oil burning, 72 per cent.

Between these limits—which by the way are not extreme—are many cases where the increase in cost will not be so much as 69 per cent. or the saving from oil burning will be less than 72 per cent., and at some points in between we shall find places where there will be no difference in cost whatsoever. The two illustrations will, however, serve to show how great may be the saving from the use of oil in certain places and how impossible is its use in many others.

With this summary we may leave the first phase of the economical possibilities of the use of fuel oil, to take up in the August issue the discussion of the second phase, and in connection with it a rapid review of the present and possible output of petroleum in the United States.

Editorial Comment

It has always been a favorite assumption of the Nicaragua Canal advocates that all the possible difficulties of the problem, both physical and political, belonged only to the Panama proposition, while the Nicaragua project was all sweetness and light. In Nicaragua every prospect was pleasing and not even man was vile. On this last point they were especially strong—as much so, indeed, as on the similar one of the alleged superior sanitary claims of Nicaragua. The similarity lies in the fact that both assertions rest on equal bases—rosy assumption in regions where there is as yet absolutely no experimental knowledge by which assertion could be tested. As one skeptical commentator said of the extravagant claims for the healthfulness of the Nicaraguan region, it is difficult to prove or to disprove any alleged vital statistics concerning a district peopled only by monkeys. Nicaragua had not been demonstrated to be unhealthy because no large force of unacclimated persons had ever been at work there. They overlooked or ignored the fact that the absence of disease and death records for Nicaragua was due wholly to the sufficient reason that there had not been people there to get sick or die.

Like inconclusiveness attaches to the other pet assumption—that there would be no political, factional, or local difficulties in the way of completing arrangements with the other Republics if the Panama negotiations were given up in favor of the alternative—an agreement with both Nicaragua and Costa Rica for the necessary concessions and territorial rights for the construction of the Nicaragua Canal. It is not apparent, to say the least, why it should be easier to deal with two petty States than with one; it is still less apparent why it should be easier to deal with them after we had given them a monopoly of the canal-route market by discarding Panama than it is now to deal with the latter State while an alternative remains. But there is another aspect of the case which is even less conjectural, to which scarcely any reference has been made, and in which certain "suppressed disadvantages" of the Nicaraguan project might be predicted with the utmost certainty. These are in all that concerns securing title to the necessary land and concessions, as distinct from questions of treaties or of "sovereignty" over the canal zone or strip.

At Panama there is but one owner to deal with. All titles, whether to land or franchises and concessions, have merged in the single title of the single corporation. But in Nicaragua and Costa Rica the titles and claims are legion. The whole region is plastered with concessions. It is quite certain that if those statesmen whose opposition to Panama took the form of extreme regard for the supposed interests of former claimants to title there should be equally punctilious in the case of Nicaragua, they would go to their long rest before the opposing claims were all filed, and their grandchildren would see the cases, still in full vigor, making their leisurely progress through the slow processes of adjudication.

We are glad to print the subjoined letter to the editors, for its historic interest in connection with the choice of the route for the Isthmian Canal:

The Editor of The Engineering Magazine.

Sir—Having read in the June number of the Magazine the communications by Gen. H. L. Abbot and George S. Morison in relation to locks, lakes, and dams for the Panama Canal, I desire to bring to the attention of your readers the plan of the engineers who were with Ferdinand de Lesseps on the Isthmus for fifty days in February and March, 1880, and which was accepted by him, and so the work on the canal begun in 1881, and with few changes continued up to the present time.

I quote as follows from the report, dated Panama, February 14, 1880:

"Fourth Question. *Means to be employed to overcome the difficulties presented by the Chagres River, and of excavating rock below the sea level.*

"The difficulties presented by the Chagres will be overcome, in the first place, by the construction of a dam at Gamboa, between Cruces and Matochin. This work was the subject of a special study conducted by M. Dauzats, *From Gamboa to the Sea.* The commission expresses the opinion that a dam of forty meters in height would provide for the storage of a volume of water 1,000,000,000 of cubic meters, a quantity equal to the maximum estimate of the freshet of November 25, 1879, the greatest that has ever been recorded (1880), as given by Col. G. M. Totten. This work will be completed by the construction of a new channel for the regulated flow of the river from the Gamboa dam to the sea. Another similar but narrower channel will be provided on the opposite side of the canal, for the streams and drainage on that side. As regards the rock to be excavated under the sea level, the commission is of the opinion that no greater difficulties will be encountered than such as are met with in similar work elsewhere, and that the greatest part of the working places can be freed from water by pumping."

The length of the dam at Gamboa was calculated at 1,000 meters.

The report from which I have quoted was signed by the following persons, many of whom are no longer in this world: *G. M. Totten, J. Dirks, E. Boutan, *W. W. Wright, *J. Dauzats, *Pedro J. Sosa, Alejandro Ortega, A. Couvreux, *Fils,* *Gaston Blanchet.

Those marked with an asterisk the writer of this knows to be dead. Abel Couvreux is one of the directors of the present New Panama Canal Company.

Nathan Appleton.

New York, June 12, 1903.

* * *

Just as Col. Stewart's leading article in this issue is coming from the press, the announcement is made of a proposed automobile highway, laid with steel plate rails, to extend the length of Long Island. While primarily conceived for pleasure travel and speed trials, the project contemplates the turning of the road to economic uses also. It is suggested that the road be given over to freight traffic during the night hours, leaving it free to pleasure vehicles during the day. "Motor trucks, moving at twelve miles an hour, could cover eighty-four miles between midnight and seven o'clock in the morning. This would extend the available garden district of the island to double its present length, and, counting a width of five miles, would lead to the clearing, fertilizing, and cultivation of two hundred square miles of land now barren."

This seems to be a sound and useful development of the functions of the business automobile. It is applying it to the sort of duty where its good points all tell, and its shortcomings are least noticeable. It combines the flexibility and the "house-to-house" serviceableness of horse haulage with the long-distance endurance and (partially at least) the speed of the railway. In traffic in which certainty of continuous movement from shipper to receiver is important, and avoidance of rehandling an important object, and in traffic, moreover, which has always stood a relatively high transportation rate, the automobile ought to find a special field where it can outrival the old alliance of the railway and the teamster. But even here, as soon as a serious development is proposed, it is noteworthy that the motor truck is preparing to follow the advice given in kindly spirit by Col. Stewart and "get onto the roadway its father, the locomotive, found the best."

* * *

It is very interesting to find, however, that after three-quarters of a century's experience of the conduct of self-propelled vehicles on rails, the opponents of the idea have exhumed the old objections which did duty before the thing had ever been tried. One report is so completely delightful in its innocence of logic and its confusion of ideas that it must be quoted: "Quite an authority on automobile track racing, (who has) held the American championship for some time, . . . said emphatically and without hesitation that a steel track would never work. In the first place, the cars' wheels would not 'bite' the steel, he said, and if they did the car would go so fast it would turn over and kill its driver. He said that no very hard surface would ever prove good for fast going with pneumatic tires. He said he tried to race on the hard sands of the Florida coast, and his car's wheels simply spun around in one spot and threw up great clouds of sand."

But it may be that the opinions of the distinguished authority have not been accurately transcribed, and that to the reporter rather than to the automobilist is due that reminiscent aroma of the tea-party attended by the Hatter and the March Hare.

* * *

We are glad to give space to the following letter from Mr. Stewart, whose article leads this issue. The letter needs no comment to explain it:

The Editor of The Engineering Magazine.

Sir—Since the attempted Paris-Madrid race all men have at least a partial realization of the danger of turning locomotives loose; that is to say, running engines on wheels at high speed off of guiding rails; and some will say in regard to that part of my article which points out that danger, that it is easy to be wise after the event, they inferring that the article was written after that race. You might mention that it was written and in print before that race.

The full lesson taught by that contest may be seen when we consider:—

1.—That the automobiles were all going in the same direction.

2.—That the road had been cleared for them by warnings far and wide.

3.—That 10,000 soldiers and police were detailed to keep people out of the way.

4.—That the chauffeurs were men selected from hundreds or thousands for their skill, judgment and nerve.

Yet the slaughter was so great that the French and Spanish governments interfered and stopped the race.

Suppose that the conditions had been those of ordinary traffic—automobiles going in both directions; the road not cleared for them; no army stationed along the route to keep people out of the way; and the vehicles guided by men of average skill, judgment, and nerve. The course would have been a field of blood.

In automobile races on common roads the prizes should not be given to the swiftest vehicle, but to those which at a certain limited speed kill and cripple the fewest people.

In the Paris-Madrid race higher speed was achieved than that quoted in my article, but no higher than has been made by locomotives on rails *pulling trains*. That is to say, the fleetest racer among the automobiles only equals the speed of a heavy draught-horse (iron horse) on the railway, and that draught-horse pulling a load two or three times his own weight.

Sylvester Stewart.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

A LABORATORY OF NAVAL ENGINEERING EXPERIMENT.

SCOPE AND PURPOSE OF THE INSTITUTION TO BE ESTABLISHED AT THE UNITED STATES NAVAL ACADEMY.

Rear Admiral George W. Melville.

ECONOMY and efficiency are recognized as dominating considerations in the industrial world. It is highly interesting to note the extension of the same principles into the domain of military engineering—to find them, indeed, supplying the text of a strong argument, by so eminent an authority as Admiral Melville, for the establishment by the United States Government of a naval engineering laboratory. In an address delivered before The Engineers' Club of Philadelphia and reprinted in the *Journal of the American Society of Naval Engineers,* the Admiral outlines the purpose and scope of the proposed laboratory, and in pointing out its importance makes an able plea for the adoption in the navy of that policy of wise expenditure on study and experiment which has been generally accepted by the greatest civil corporations.

The act making appropriations for naval construction for the year beginning July 1, 1903, provides for the building of five battleships which, with armor, armament, and equipment, will cost, the Admiral estimates, about $7,000,000 apiece. The laboratory authorized in the same act, with its equipment, is to cost not exceeding $400,000. Admiral Melville takes as his starting point the small proportion which this outlay bears to the saving it may secure, and his argument is best presented by his own words:

"The annual depreciation of each of these vessels from the time they are launched, taking into consideration wear and tear as well as loss in fighting value, will be at least 4 per cent. of their actual cost. The expense attending the establishment of the proposed experimental station, including its operation for several years, will thus be but little more than the annual loss resulting from corrosion, mishaps, and depreciation of military appliances of two of these floating fighting machines.

"A few hundred dollars spent in well directed and conscientious experiment may result in the saving of hundreds of dollars elsewhere. The cost of maintaining a battle-ship in commission will approximate $1,000 per day, and war-ships have been tied up for weeks on account of the corrosion of a few hundred dollars' worth of boiler tubes. It will repay the nation for the cost of the laboratory if the staff of the laboratory will simply cause increased length of life of both boiler and condenser tubes.

"The rise of Germany as a naval and maritime power during the past thirty years has surprised the world. I believe that her battleships for their tonnage are the best afloat, because they possess a triple-screw installation of machinery, thus giving the motive power of her larger warships economical, structural and tactical advantages over similar high-powered vessels of rival nations. Her ocean greyhounds are the largest, fleetest and probably the most economical and comfortable afloat. Strangest of all, this excellence in the construction of warships, as well as in the building of vessels for the ocean-going trade, is not the result of a progressive series of failures, either in design, construction or of operation.

"The success of Germany can only be accounted for by recognizing the fact that study, reflection and research must have been expended in the preparation of plans, in the building up and the organization of the shipyards, and in laying out and carrying on the work of construction. It was the high appreciation of the value of original investigation, coupled with experimental work, that has caused Germany to advance progressively and successfully.

"For over a hundred years Germany, as a nation, has carried on more original research along technical lines than any other power. While it is true that both England and America have put to practical application the principles discovered by German research, thereby gaining commercial and maritime advantages, it has been the Teuton who has sought after principles, and thus the world is primarily indebted to this studious and thoughtful race for many of the great discoveries and inventions.

"In a desultory and sporadic manner all naval powers have done some experimental work. It is because original investigation is not always appreciated in its fulness by the Anglo-Saxon that many administrative executive officers are indifferent to such research, and therefore experimental tests in Great Britain and America are not always of a continuing nature.

"The cost to the British Government of using the cruisers *Hyacinth, Minerva* and *Hermes* for comparative boiler tests and experiments will approximate more than the cost of establishing and operating both the Charlottenburg and Dresden Stations since their inception.

"If it be true that the battleship of one generation is the junk-heap of the next, then an economical race like the German is pursuing a wise policy in conducting experimental research and investigation in the direction of finding out how the weak links in the naval chain can be strengthened.. In the race for naval supremacy it is bullion, as well as brains, that counts.

"Experience has shown that the German engineering laboratories are more than a good paying investment, for there is not an expert in that empire familiar with the work being done at these laboratories who does not believe that their destruction would be a greater national calamity to the navy and the nation than the loss of one of the battleships of the home squadron. The warship could be replaced in four years. It would take six years to rebuild and put in effective operation the complete installation for conducting experimental research that has been developed and perfected at the Charlottenburg and Dresden technical colleges. . . . One does not need to possess vivid imagination to realize that much is contributed to the fighting strength of a navy by carrying on research along engineering lines, and thus preventing the design, construction and installation of appliances that are ill suited for the purposes intended.

"It can be absolutely stated that the navy is behind the times in original work and research. Several months ago one of the marine superintendents of one of the Great Lake Transportation Companies told me that if he was called upon to retrench in expenditures the last item to be cut down would be that for experimental purposes, since both the cost of construction and the expense of operation of the steamers under his control had been reduced as a result of the data secured from experimental work. There is not a leading university, large manufacturing concern, nor great transportation company that does not consider it imperative to make tests and experiments. Every navy will also find that it will increase efficiency and promote economy to conduct and to encourage extended investigation of unsolved problems relating to its marine service."

As to the organization and work of the naval engineering laboratory, Admiral Melville says:

"In collaborating the information received from various sources, the Bureau is of the opinion that the laboratory at Annapolis should in many essential respects be patterned after the Charlottenburg school along steam and material-testing lines; after that of Dresden as repects gas-furnace installations and hydraulic appliances; and after the Swiss school at Zürich in the equipment of apparatus for testing that class of turbines which work under low heads.

"As for the character of the laboratory building and its furnishing, the technical college at Liverpool should serve as a model, since the building of this institution is an ideal one in many respects, especially as regards light and ventilation.

"The field to be covered by experimental research along engineering lines is vast. The following are only a few of many urgent problems, in the solution of which the navy has a direct interest:

"1. The value of liquid fuel for various naval purposes.

"2. The possibilities of the steam turbine for installation in warships.

"3. The efficiency of various forms of propellers.

"4. The relative advantages and disadvantages of in-turning and out-turning screws.

"5. The reduction of vibration of machinery.

"6. Limits of economical increase of steam pressure.

"7. The development of practical appliances for utilizing the advantages of superheated steam.

"8. A proper ratio of sizes of cylinders for multiple-expansion engines.

"9. Improved systems of economy in auxiliary machinery of naval vessels.

"10. The value of condensed fuel, such as briquettes, etc.

"11. The relative advantages of straight and of bent-tube types of boilers for torpedo boats, gunboats, cruisers and battleships.

"12. The corrosion and deterioration of boiler and condenser tubes.

"13. The relative value of various alloys for machinery purposes.

"14. The types of valve gear most suitable for naval purposes.

"15. The endurance of the storage battery and its possible development.

"16. The more extensive use of steel castings.

"17. The question of lubricants.

"18. Calibration of gauges and of instruments necessary for naval engineering purposes.

"19. The proportions of centrifugal fans.

"20. The most effective systems of forced draft for various classes of warships.

"21. Mechanical refrigeration, the present method of cooling magazines being far from satisfactory.

"22. Testing non-conducting and fireproofing materials.

"23. The determination by actual test of the best proportions of important engine details.

"24. The study of the problem of how to secure more complete and definite information upon trial trips.

"25. Reliable form of water-glass gauge that will be applicable for forced-draft conditions as well as when muddy feed water is used.

"All of the large industrial and transportation corporations maintain complete testing department or bureaus of tests, presided over by experts of national reputation who have under them an ample corps of assistants. The work done at these laboratories in advancing and improving the character of railway and manufacturing appliances has been of great financial gain to the several corporate interests.

"If a private corporation finds it essential to maintain such a testing plant, how much more should the navy—a corporation of far greater size—find the maintenance of such a station profitable for the direct return secured, but likewise necessary for preventing retrogression?"

BRITISH COAL TRADE.

THE GROWTH AND DIRECTION OF THE EXPORT COAL TRADE OF GREAT BRITAIN IN THE LAST HALF CENTURY.

D. A. Thomas—Royal Statistical Society.

IN an important paper recently presented before the Royal Statistical Society, Mr. D. A. Thomas, M. P., discussed the relation of the export coal trade of Great Britain with reference to general industry and manufactures, and some abstract of the paper is here given.

During the fifty years between 1850 and 1900, the quantity of coal produced in the United Kingdom and retained for home consumption more than trebled; or regarding it *per capita*, about doubled. In the same period the quantity exported, including that shipped for steamers' use, increased about fifteen-fold, rising from 6.8 per cent. to 26 per cent. of the total output. Considered from a commercial standpoint, these figures may be found very satisfactory, but the possible want of permanence, and the ultimate influence of the export of a natural resource upon national prosperity must be considered.

It is naturally maintained that a corresponding equivalent must come into the United Kingdom in exchange for the value of the coal exported, but Mr. Thomas points out that the money value of the coal is not altogether the index of its importance to the nation, since a large proportion of its cost goes in labor. The winning of the coal exported occupies about 200,000 colliers, apart from the railway and dock hands who handle it, while in 1900 it was estimated that about twenty millions sterling was paid to ship owners for freight.

Much has been said about the dependence of the United Kingdom upon foreign countries for its food supplies, but the weakness of this position has been fully overcome by the possession of coal, which has enabled Great Britain to maintain her commanding position in spite of the fact that a large portion of her food comes from over sea. With the exhaustion of the coal supply, however, this position will necessarily be changed, and although it is possible that other sources of energy will be discovered and utilized, these will doubtless be shared by other nations to an extent which will deprive England of a portion, at least, of her pre-eminence.

While the importance of this question must be admitted, it is impossible to see how the possibilities of the future can be mitigated. Any attempts at the restriction of export can produce but a partial remedy, and, in fact, would be almost impracticable. Every successful attempt in the reduction of the cost of production, and every increase in the economy of consumption, must extend the field of its use and so stimulate the general demand.

Naturally, the great demand which has arisen for coal has been due to the wide extension in the use of steam during the past fifty years. A very large proportion of the British coal which has left the Kingdom has been required for the purposes of steam navigation, in connection with the enormous growth of over-sea commerce with all parts of the world. In this connection it is interesting to observe that by far the greater portion of the coal leaving the United Kingdom has not been for consumption in other countries, but for use in vessels carrying the British flag. Nevertheless, the coal is being consumed and the home stock is continually growing less, and thus the national capital is steadily being used up. It is not necessary that British coal supplies should be entirely consumed before British supremacy is imperilled, since the increase in depths must cause an increase in cost which will begin to be felt long before the carboniferous measures are exhausted.

Viewed from the other side, however, the export of British coal forms a most important element in commerce. Considered as cargo for outward-bound ships, it constitutes more than four-fifths of her exports, and without it the great bulk of the shipping bringing in such staples as cotton, corn and wool would be obliged to clear in ballast for lack of sufficient cargo.

Mr. Thomas emphasizes the fact that the discussion of the coal question by the late Professor Jevons has been fairly well confirmed in the light of modern fuller knowledge. The experience of thirty-five years has proved his main conclusions to be substantially true, minor details only being subject to slight modifications.

So far as other parts of the world are concerned the coal question, while important, has not the national significance which exists in Great Britain. The coal strike in the anthracite regions of Pennsylvania caused temporary inconvenience in many places where bituminous coal is not used, but the supply of the latter in the United States is practically inexhaustible, and with proper provision for its complete combustion, it may readily be substituted for anthracite when occasion may require. Besides the United States, the coal measures of Canada and British Columbia must be remembered, together with the deposits in Alaska and in Japan, as well as the enormous strata in China. There is no fear for the coal supply of the world, but as for the United Kingdom, her coal resources may well demand just such a careful study as Mr. Thomas has given them.

TIMBER FOR RAILROADS.

THE ECONOMIC USE OF TIMBER BY RAILROADS AND THE IMPORTANCE OF ITS PROPER PRESERVATIVE TREATMENT.

Dr. Hermann von Schrenk—Prof. B. E. Fernow.

THE daily papers have recently chronicled the fact that one of the principal railroads of the United States has made arrangements with the National Bureau of Forestry to conduct extensive practical experiments in the use of ties made of the cheaper and more accessible kinds of wood, treated by preservative processes. The scarcity of the supply and the increase in the price of wood which, in its natural state, is suitable for ties, have forced the railroads to look into the possibility of utilizing local supplies of timber which has hitherto not been available, owing to its rapid deterioration.

The experts of the Bureau of Forestry have been urging the economic advantages of the preservative treatment of timber for ties, telephone and telegraph poles and other purposes for many years, and elaborate experiments along these lines have been, and are being, carried on, notably at the United States Government Experiment Station at St. Louis, under the direction of Dr. von Schrenk. This missionary work is beginning to tell, and railroad men are paying more serious attention to the exhortations of the forestry experts, and are coöperating with them in a practical way.

This favorable condition of affairs lends particular interest to two papers which were recently read before the New York Railroad Club, one by Dr. Hermann von Schrenk on "The Use of Timber and Its Relation to Forestry," and the other by Prof. B. E. Fernow on "Railroad Interests in Forest Supplies."

Dr. von Schrenk considers the following main points: 1. The present use of wood and where it comes from. 2. What we may expect to get some years hence. 3. Probable methods to be adopted for assuring a constant and adequate future supply of timber.

The railroads employ wood to-day for ties, bridge materials, fence posts, piling, and telegraph poles, and for buildings and cars. The timbers used for these various purposes are of all kinds, but chiefly white oak and chestnut in the East, and various pines in the West for ties, locust, chestnut and cedars for fence posts and telegraph poles, and yellow pine and Oregon fir for bridges. The sources of the present timber supply are more narrow than they were in the past. When large forest tracts were to be found in almost every State, the timber was mostly cut locally, but now, although some wood is thus secured, the larger quantities come from a distance. Pine from Georgia and cedar from Canada are sent to the railroads about New York, the roads in Iowa haul oak 700 miles, and one road in Colorado brings pine from southeastern Texas.

If present methods are allowed to continue unchecked, the local growths of suitable timber will be entirely exhausted for most of the railroads, and they will have to go to greater and greater distances in order to get supplies. Even the great forests still standing in remote parts of the country will not be able to meet the demand upon them indefinitely, and although they may hold out for a good many years, the higher prices of timber and the increasing uncertainty as to getting the quantities and kinds desired have directed the attention of those in charge of the management of large interests dependent more or less on forest products to the possibilities of re-establishing a safe and lasting local supply, with increased service obtained from the timber, all of which means forestry in its best sense.

The methods by which this end will probably be reached are: 1. Proper management of existing tracts of forest lands so as to yield a constant supply without destroying the forest. 2. Re-planting cut-over or treeless areas not fit for agricultural purposes. 3. Timber preservation, involving the chemical treatment of timber to obtain longer life, and consequently insuring the cutting of smaller quantities from the existing forests.

Up to the present day lumbering operations in the United States have generally been carried on from the standpoint of realizing the greatest amount from any given forest tract without regard to future operations, but the time has come when very different lumbering will have to be resorted to, and not merely because of sentiment, but for reasons of sound business policy. A forest consists of trees of the same or different kinds which grow continuously from year to year, and every year the amount of timber on a tract increases in quantity and consequently in value. Some trees grow faster than others, but at a certain period in its growth, a given tree will reach its point of maximum value. Suppose, now, that instead of cutting off the whole forest at any one time, only such trees as have reached this point of maximum value are cut, and the remainder allowed to grow until they also have reached their corresponding maxima. Given a forest tract of sufficient size, on which young trees are constantly replacing those cut out, it will be evident that continuous cutting can take place on such a tract, without destroying the forest as a whole. When we know the rate at which any given trees grow, it becomes a comparatively easy matter to determine with some degree of accuracy what one can expect in the way of returns from a tract year after year.

It is according to this system that the forests of Germany, Switzerland, and other European countries have been worked for many years, and such lumbering is bound to come in the United States. In fact, it is already being tried, in a tentative way, by some large timber operators and on some private estates.

The second method for producing future timber supplies consists in planting trees on areas which as a rule are not fit for agricultural purposes. This can be carried out to a limited extent by individuals, but it can be done best on a large scale by governments and great corporations which can afford to wait many years for a slow but sure return on an investment.

The third method which will aid in assuring a future supply of timber consists in preserving the wood against decay, wear and fire. In order that timber preservation shall be economically as well as technically successful, the following questions must be considered and rightly answered: 1. What timbers ought to be preserved? 2. What preserving methods should be used? 3. How should the preserving be done? 4. Who should do the preserving?

The value of any particular wood for tie purposes has so far depended largely upon its power to resist decay. The most valuable timbers, like the white oak and the long-leaf pine, were used because they lasted longer than others, which meant a saving in the renewal costs great enough to warrant a high first cost. For present purposes such woods may be spoken of as high grade, to distinguish them from those that are short lived when in use, like red oak, loblolly pine and hemlock, timbers which it has not paid to use hitherto because of the necessity for frequent renewals. The high-grade timbers are, as a rule, dense, hard woods, which absorb water slowly, and for this reason, and possibly also because of the presence of antiseptic substances, are not as rapidly attacked by wood-destroying fungi. The injection of chemicals into timber does away with this distinction and sets up another. The longest lived preserved timber (speaking with reference to resistance to decay alone) will be the one which will allow of the most perfect and even penetration of the preservative, and which at the same time will hold such a preservative. Long life alone, however, is not the prime consideration, but rather the greatest return on the original investment, which consists of the first cost of the timber and the cost of the preservative process. It so happens that the open-grained, porous woods which, when untreated, last but a comparatively short time, allow a deep penetration of the preservative and thus have their life greatly lengthened, while the denser woods, which ordinarily are called long lived, resist the penetration of the preservative and gain only a little in the length of their life as a result of treatment.

The experience of the Eastern Railway of France confirms these statements: Untreated oak ties gave this railroad an average life of twenty years. The treatment added five years to this. Untreated beech lasts about four or five years, while the treated beech has so far given an average life considerably over thirty-five years.

It so happens that porous timbers, as a rule, come from rapidly growing trees, which means short periods of rotation of a forest under management, and consequently a definite and sure future supply; and, moreover, these timbers are still plentiful in most sections of the United States and are easily accessible to the railroads. It will thus be seen that all circumstances combine to make the cheaper, short-lived timbers the most suitable for treatment by a good process, and for subsequent use.

Dr. von Schrenk enumerates the principal preservative methods, as follows: 1. Creosoting or tar oil treatment. 2. Burnettizing or treatment with zinc chloride. 3. A combined zinc chloride and tar oil treatment in its various forms. 4. The Hasselmann process, or boiling in copper-iron aluminum sulphate. There are other processes, which are being experimented with, but which have not been in use long enough for conclusive data to be derived from them.

To get good results, great care should be taken in the preservative process, and the timber should be thoroughly seasoned before treatment. The work should be in charge of competent men, and it would be advantageous for a railroad to organize a forestry and timber department, with an expert at the head of it.

Prof. Fernow confirmed Dr. Schrenk's statements as to the wastefulness of former lumbering operations and the necessity for more scientific and rational methods in the future. He also believes that preserved ties will be much more economical in the long run than untreated ones, and for renewal purposes, on roads already built, he advocates the use of preserved ties. But he thinks that even the preserved tie must ultimately give way to the metal tie, which will be the tie of the future, and which should now be employed in new construction.

These papers and the ensuing discussion before a large body of practical men, are evidence of the intelligent interest which is now being taken by some of the great railroads and telephone companies in economic forestry and timber preservation, and give promise that the remaining supplies of timber in the United States will not be wastefully used up, but will be regarded as a great source of national wealth which must be carefully administered for the benefit not only of the present, but of all future generations.

ELECTRIC FURNACES.

THE PRESENT STATUS OF THE ELECTRIC FURNACE IN METALLURGY AND SMELTING OPERATIONS.

Albert Keller—Iron and Steel Institute.

NUMEROUS attempts have been made to utilize the electric furnace for general smelting purposes, and many claims, some of them extravagant enough, have been made for various devices. For this reason the paper of Mr. Albert Keller, presented at the recent meeting of the Iron and Steel Institute, is to be welcomed, since it gives in a reliable and authoritative form the present claims of the electric furnace to be considered as a practical metallurgical appliance.

As is well known, the electric furnace has been used almost exclusively for the reduction of such refractory materials as resisted the lower temperatures of ordinary furnaces. Examples of such applications are found in the production of calcium carbide, of carborundum, artificial corundum, and the like, as well as for the reduction of metallic aluminum, involving the use of the electric current as a reducing agent. These applications have been made upon a large scale, the utilization of hydraulic power for the generation of the current having been applied especially to the manufacture of calcium carbide between the years 1894 and 1901. The crisis in the calcium carbide industry, however, caused many plants to be idle, with the result of stimulating efforts to apply the apparatus to other departments of work. It was found, however, that modifications were necessary in the furnaces in order to adapt them to general metallurgical purposes, since the hearths which served for the conductors of the current were made of carbon, and the metals or alloys to be reduced would absorb an excessive proportion of carbon, almost impossible of elimination afterwards.

Mr. Keller discusses these modifications at length, showing how the electrical furnace, from being a special apparatus, with its applications closely limited, has become a metallurgical adjunct of greatly enlarged scope.

Electric furnaces may be divided into four classes. The first and oldest of these includes the various forms of electric arc furnaces, in which an arc is produced between two electrodes or between one or more electrodes and the hearth. In these furnaces the heating is effected by the direct heat of the arc, and it is impracticable to fill them up with the material, so that this type is not adapted for the reduction of ores. Such furnaces, however, are well suited for the fining of metals, and they have been successfully employed for such work.

The second class includes electric resistance furnaces, in which the electrodes are immersed in the material in the process of fusion. Here the temperature is in proportion to the surface of the electrodes, and a distribution of the calorific action can take place over extensive surfaces, depending solely upon the power absorbed. This style of furnace is especially adapted for the reduction of ores, since the control of temperature during working is a simple matter, and the liquid metal can always be run off at the lower part of the furnace. The action of such furnaces is similar to that of a blast furnace, the hot zone of the tuyeres being replaced by the mass intervening between the two poles.

In the third class is found what may be called surface resistance furnaces. In these the electrodes alone do not afford sufficient section for the passage of the current, and it is necessary to connect them by means of some conducting material, such as a bed formed of pieces of carbon. This bed is thus brought to a state of high incandescence, forming a melting hearth upon which the material is placed. This type of furnace may be used, fully charged, for the reduction of raw material, or it may be employed for fining a metal or alloy by arranging the electrodes so that they hang just above the molten material, but are not immersed in it.

The last class contains what are called electric induction furnaces. These are in the form of an annular crucible, the contents of which form the secondary circuit of a transformer, the primary circuit being arranged in the ordinary way. Such furnaces, which are by no means new, have but a limited application in practice, but are available for the fining of liquid charges of metal in the crucible.

By far the most interesting portion of Mr. Keller's paper is that describing the works of the Thermo-Electric Company of Paris, in operation at Livet, in the valley of the Romanche. Here there is a flow of 25 cubic metres per second, with a head of 64 metres (210 feet), giving a total of more than 20,000 horse power available, although but a portion of this is at present utilized.

The operations at Livet include the use of electric blast furnaces and electric fining furnaces, the former reducing the iron from the ore, and the latter converting the molten charge into steel. In general appearance the blast furnace resembles the ordinary high-furnace with the addition of a large hearth below, and without the usual contraction at the boshes. Four large carbon electrodes enter the furnace at the hearth level, while the shaft above contains the ore, fuel and flux, as in the ordinary blast furnace. When the furnace is started the fusion and reduction takes place, at first only upon the hearth, but after working for some time the materials contained in the upper part become sufficiently heated to enter into reaction. It thus appears that the work is done partly by the electric current and partly by the fuel, there being no blast, and the heat of the fusion zone being entirely supplied by the electricity.

The molten metal from the high-furnace is drawn off into the fining furnace, this containing only a partial charge, the electrodes not being plunged into the bath but suspended above it so as to be clear of the slag. The process is similar to that in the open hearth, except that the mode of heating is neutral. The decarburization is effected principally by the aid of metallic oxides, and the product closely resembles crucible steel.

Mr Keller gives cost of the plant, which, including a depreciation of one-tenth per annum, entails an establishment charge of 20 shillings per kilowatt-year. To this must be added the operative charges, the ore being 10 shillings per ton, and containing 65 per cent. of metallic iron, and the cost of coke being 48 shillings per ton. He concludes that electric smelting cannot compete successfully with existing methods when the cost of electrical energy exceeds 25s. 6d. per kilowatt-year, but shows that this cost may be reached in situations where water power is available.

The works at Livet is an installation where the electric smelting of iron and the production of steel has been undertaken on a far larger scale than elsewhere, and as such it is worthy of notice.

In view of the superior quality of the steel produced in the electric fining furnace, it is probable that the process may find extended application, using molten pig-iron from the ordinary blast furnace. In this case the cost comes within practicable limits, and the character of the product renders the commercial side of the question one which will bear examination.

CLIMATOLOGY OF THE ISTHMUS OF PANAMA.

A SUMMARY OF THE METEOROLOGICAL CONDITIONS AFFECTING THE CONSTRUCTION OF THE CANAL.

Gen. Henry L. Abbot.

A RECENT contribution to the *Monthly Weather Review* is noteworthy not only for the distinction of its author and the thoroughness of its analysis of meteorological data, but also as affording the most complete development yet attempted of the conditions which must be met and controlled in the building of the Isthmian waterway. It is in this connection that General Abbot undertook the analysis of the statistics available to date as the result of the work carried on during twenty years past by the two companies operating on the Isthmus. Regrettably, only the barest outline of the entire study can be given here, and none of the interesting and valuable tables.

"In considering the climate of the Isthmus," says the General, "as compared with that of more temperate regions, attention is attracted by the remarkable uniformity of temperature throughout the year.

"The general elements which determine this uniformity are the direct heat received from the sun; the influence of the excessive volume of aqueous vapor held in suspension in the atmosphere; the influence of the two great seas which wash the shores of the narrow belt of land constituting the Isthmus. The influence of the seas depends on their varying absolute temperatures and on the movements of the atmosphere, as these, in a large measure, regulate the effect of the oceans in different months.

"The relative intensity of the solar energy received during the month may be regarded as proportional to the sine of the altitude of the sun at noon, and its relative duration as proportional to the length of the time that it is above the horizon on that day. It is, however, to be noted that the length of day, and hence the duration of solar radiation, attains its maximum in June and its minimum in December; and that this element therefore tends to reduce the natural fall of temperature during the northward journey of the sun, and to augment it during the approach to his southern limit.

"But the temperature of the air, as registered by the thermometer, is affected by the modifying influence of the aqueous vapor held in suspension, which opposes great resistance to the energy radiated from the sun by day, and still more to that radiated back from the earth both by day and by night. By day this vapor tends to largely reduce, and by night to largely increase, the temperature of the air at the earth's surface.

"It remains to consider the influence of the two oceans bordering the Isthmus. The old canal company made daily observations of the temperature of the water at Colon and at Naos for four years, from 1884 to 1888. At Colon the annual average was 79.3° F., the maximum, 81.9°, occurring in September, and the minimum, 75.8°, in February. At Naos these figures were 76.1°, 80.0° occurring in October, and 67.80° in February. The general movements of the atmosphere, which in a large measure determine the influence of oceans upon neighboring shore climates, are here governed by the locus of the ascending current of warm air which follows the sun in its travels north and south between the solstices. When the sun is north of the Isthmus southerly winds prevail, and when south, northerly winds.

"As is the case with monthly means, the changes of temperature from hour to hour and from day to day are subject to much less variation on the Isthmus than in regions more remote from the equator. Alhajuela is situated in the valley of the upper Chagres, among the hills which here represent the great mountain chains bordering the western coast of North and South America. Its altitude above tide is only 144 feet, and being about midway between the oceans the locality is well suited to represent the climate of the interior of the Isthmus. The temperature at sunrise in the dry season is about 72°; it soon rises rapidly, attaining about 87° at 1 p. m.; after this it falls rapidly to about 81° at sunset, and then subsides gradually to the minimum at sunrise. During the rainy season the temperature at sunrise is about 74°; it rapidly reaches a maximum at noon, about 85°, and then falls to about 80° at sunset, and later to the minimum at sunrise. Thus, during the dry season the daily temperature has a larger range and a later maximum than when rains prevail.

"At La Boca, situated on the Bay of Panama, the minimum temperature occurs later, or at about an hour after sunrise, being then about 75° in both the dry and the rainy seasons. The maximum in the dry season, 86°, is reached at about 4 p. m., and in the rainy season, 84°, at about half past 2 p. m. The rate of fall is more gradual than at Alhajuela, the mercury receding at sunset in the dry season only to about 86°, and in the rainy season only to about 83°. In short, the changes on the Pacific coast are less extreme and are later than in the interior, but the daily average is about the same.

"An annual rainfall of about 140 inches may be expected on the Atlantic coast, about 93 inches in the interior, and about 60 inches near the shores of the Pacific. There is a well-defined dry season beginning in December and including the months of January, February, March, and part of April, a period during which the sun is returning northward from his southern journey to the Tropic of Capricorn, and the locus of heavy rainfall has been transferred southward from the Isthmus. This comparative exemption from rain is characteristic of the interior and of the Pacific coast, but somewhat less so of the region bordering the Caribbean Sea. Clearly, it is an important advantage to be able to depend upon having several consecutive dry months in which to prosecute the laying of concrete and other difficult work during the construction of the canal.

"The health statistics during the construction of the Panama Railroad have never been made public, but are well known to have been appalling. At that date it was not understood that natives of the temperate regions can not safely perform arduous manual labor under exposure to a tropical sun, and that dependence for such work must be placed upon the negroes of the West Indies. White men can supervise, but must not attempt more. Fortunately the health records during the canal operations, and especially those during the operations of the new company, which should furnish the best guide in view of the great changes in the physical condition of the region, have been preserved. Dr. Lacroisade, for many years the medical director of the fine company hospital near Panama, is thoroughly familiar with the Isthmian conditions, and the notes following are a translation from a letter written by him. He attributes marked improvement to the better accommodations of the laborers, to better drainage, and especially to the fact that the excavations have reached a level below the poisonous emanations of decaying matter in the soil."

From Dr. Lacroisade's letter, which follows, we summarize these general conclusions:

"Considering the average figures for the last four years, I find that with a personnel of 2,275 the percentage of disease has been 29.65, and the mortality 2.35 per cent. These figures do not exceed those on large works in any country.

"It should, however, be added that this personnel has been long on the Isthmus and is well acclimated; I may even say extremely so, since 91 per cent. of the total death rate is due to chronic organic diseases common to all countries, leaving only 9 per cent. of it chargeable to the diseases of the local climate.

"The classified employees, which constitute about 8 per cent. of the entire force, are represented in the total death rate by 5.70 per cent., while the laborers are represented by 94.30 per cent. The mortality in the latter class is therefore the greater.

"Among infectious diseases on the Isthmus yellow fever is undoubtedly the most to be feared by unacclimated persons of the white race. During the two recent epidemics of yellow fever—the first from May to December 15, 1899, and the second from March to September 10, 1900—only two cases appeared among the personnel of the company.

"I have mentioned in former reports the disappearance of yellow fever from the Isthmus from the year 1892 to the year 1897. This would lead to the belief that the disease is in no wise necessarily endemic.

"I will remark that the City of Colon, which up to about the years 1891-92, was a terrain than which nothing could be better for yellow fever—reputed more dangerous than the City of Panama—has since that time remained free from any infectious disease and has escaped the yellow fever epidemics of 1897, 1899, and 1900. This is evidently due to the sanitary works which have been executed, the filling up of the many little swamps and the cleaning of streets which before were veritable sewers. By these improvements the City of Colon has been considerably freed from the swarms of mosquitoes which rendered life insupportable.

"Might not a like result be secured for the City of Panama (1) by a good supply of pure water, (2) by drains to conduct sewerage to the sea, to which its situation and conformation are easily adapted, and (3) by watering the streets daily in the dry season, and by cleaning them daily throughout the entire year. Now they are in a repulsive condition of filth. These three improvements, which I consider fundamental and essential, are now wholly neglected.

"There should also be instituted an effective quarantine service for vessels arriving in the harbor, for beyond all doubt the epidemics of 1897, 1899, and 1900, and the few cases which occurred in January, 1901, were due to importations, in one instance from the Atlantic and in three instances from the Pacific.

"I do not expect by these measures to remove completely from Panama its character as a terrain favorable for the propagation of yellow fever; but certainly, if thoroughly applied, they would exclude some epidemics and render a residence on the Isthmus less dangerous for unacclimated persons of the white race.

"The important works executed from one end to the other of the line of the canal have also done much to improve the sanitary conditions existing on the Isthmus."

THE ACETYLENE BLOWPIPE.

APPLICATIONS OF THE THERMAL EFFECT OF THE OXYGEN-ACETYLENE BLOWPIPE IN THE MECHANICAL AND INDUSTRIAL ARTS.

André Binet—Le Génie Civil

THE uses of high temperatures in the arts have continually extended with the improvements in the means for producing them. Thus the heat of the electric arc has been applied in the electric furnace, some of the latest developments of which are discussed elsewhere in these columns. The aluminothermie of Dr. Goldschmidt is another example of the manner in which the high temperature of a chemical reaction is used for welding and fusing refractory metals, while the oxy-hydrogen blowpipe has long been employed for various purposes involving the effects of concentrated high heat.

All these methods have their limitations, however, the process of the combustion of aluminum being adapted principally for the joining of rails, the repairing of castings, and similar work, while the electric furnace appears to have found its most effective use in the manufacture, on a commercial scale, of such articles as calcium carbide, carborundum, and the like.

The most recent appliance for the production of a very high temperature in a form suitable for employment in the arts is the oxygen-acetylene blowpipe, and from a paper by M. André Binet, in a recent issue of *Le Génie Civil,* we abstract some account of the apparatus and its operation.

The oxy-hydrogen blowpipe is well known to be produced by the combustion, under pressure, of the gases oxygen and hydrogen, in suitable nozzles, the best results being obtained when the combination is that corresponding to the formation of water, or two parts of hydrogen to one part of oxygen. Various attempts have been made to determine the temperature produced by such a blowpipe, one of the earliest of these being by M. Sainte-Claire Deville, based on the cooling of a mass of platinum heated in the jet, the result being an estimate of about 2500° C. Later experiments, by Bunsen and by Mallard and Le Chatelier, have materially increased this value, the present accepted figures being about 3,300° C. The variations may be due to the various mixtures of the gases actually combining in the jet, there generally being an excess of hydrogen present, owing to the usual objection to the production of an oxidizing flame, while at the same time the abstraction of heat from surrounding objects acts materially to reduce the temperature, so that the available heat is less than would be expected from theoretical considerations. In practice it is found that the oxy-hydrogen blowpipe is unsatisfactory for the welding of pieces of steel of even moderate size, while the cost of gas becomes excessive.

Modern methods of the production of acetylene gas have results in attempts to use it as a special fuel in the arts, and among these the acetylene blowpipe offers some interesting possibilities. The calorific power of acetylene is very high, being far superior to that of an equal volume of hydrogen. Thus, the combustion of one cubic metre of hydrogen disengages about 3,100 calories, while a cubic metre of acetylene produces 14,500 calories. By the substitution of acetylene for hydrogen in the blowpipe, using acetylene and oxygen in the proper proportions, and under a much lower pressure than when hydrogen is employed, a temperature exceeding 4,000° C. is obtained in a satisfactory working form. This alone would be a most important result, but to this is added the fact that the oxygen-acetylene blowpipe is much cheaper than the oxy-hydrogen apparatus.

In the case of the oxy-hydrogen blowpipe the two gases are generally contained in strong cylinders, under a pressure of 12 to 15 atmospheres; reducing valves being provided in order to enable the proper working pressure at the jets to be maintained. With the use of acetylene, however, this arrangement is modified, the oxygen only being contained under pressure in a cylinder and the acetylene delivered directly from the generator at the working pressure.

A special advantage resulting from the employment of acetylene in the blowpipe is the ease and certainty with which the flame can be regulated. The colorless nature of the hydrogen flame renders it difficult to determine the proportions of the gases by inspection, but the brilliant illuminating power of the acetylene enables the effect of the admittance of varying proportions of oxygen to be estimated very closely by observation. This fact enables the skilled operator to produce an oxidizing, neutral, or reducing flame at will, thus greatly facilitating the use of the blowpipe for metallurgical operations.

The extent to which the oxygen-acetylene blowpipe may be employed in actual shop work is indicated by examples given by M. Binet, these including the direct welding of flanges upon steel pipes, the joining of pipes at various angles, and the like, and there is no reason why it should not be used for welding joints in boiler shells or in ship construction, since the portability of the apparatus enables it to be applied at any point in a structure with convenience.

Tests which have been made of the strength of welded joints in which the oxygen-acetylene blowpipe was used have given very satisfactory results. A tension test of two pieces of steel welded by the blowpipe showed an ultimate resistance of 35 kilogrammes per square millimetre (49,770 pounds per square inch), and in general the results of the work are fully equal to those obtained by electric welding.

As in the case of the oxy-hydrogen blowpipe, it is difficult to determine the exact temperature produced by the combustion of acetylene with oxygen in the blowpipe, since the effects of cooling, dissociation, vaporization, etc., modify the result. The experiments of M. Le Chatelier, however, show that a temperature of at least 4,000° C. is reached, and it is certain that all the metals used in the arts are instantly fused by use of the oxygen-acetylene blowpipe, burning in free air.

PORTLAND AND SLAG CEMENTS.

A STUDY OF THE MANUFACTURE OF PORTLAND CEMENT FROM BLAST-FURNACE SLAG, IN EUROPE.

Iron and Steel Institute.

At the recent meeting of the Iron and Steel Institute, one of the papers which elicited an active discussion was that presented by Chevalier C. de Schwarz, of Liége, upon the manufacture of a true Portland cement from blast-furnace slag. Ordinary slag cement, as has been frequently described in these columns, is made by grinding to a fine powder a mixture of about one-third to one-fourth of slaked lime with two-thirds or three-fourths of granulated blast furnace slag. Such a cement, in which the mixed materials are not subjected to a subsequent calcination, cannot properly be termed a Portland cement, and while it may be available for certain limited uses, it can only be advantageously employed for structures under water, or for foundations, and not for works which are exposed to the free air or to the rays of the sun.

Referring to chemical composition, it has been found that in a true Portland cement the proportion which the total lime plus magnesia bears to the silica plus alumina is about 2 to 1, while in the case of ordinary slag cements the proportion is about 3 to 2. Nevertheless, slag cement is extensively used both in Germany and in the United States, and its manufacture, mainly as an adjunct to iron and steel works, is steadily increasing.

The principal cause of the disadvantages of ordinary slag cement as compared with Portland cement appears to be the fact that the action between the lime and the slag takes place when the constituents are cold and not when in the fire, as is the case with Portland cement. The calcining of the materials together appears to increase the affinity between the silica and the lime, while in the case of the slag cement this action fails.

In order to remedy the defects of ordinary slag cement the natural idea is to calcine the limestone with the granulated slag, and this has been developed in Germany with great success. After a number of experiments, success has been attained in the manufacture of Portland cement from blast-furnace slag by mixing granulated slag with limestone in the same manner as is done with the materials used for making Portland cement—that is, by calcining the intimate mixture of these materials to vitrification, and by grinding the product of the calcining kiln, the so-called clinker, into fine powder. This product corresponds practically to Portland cement, as defined by the authorities, and is fully entitled to bear the name.

Apart from any considerations as based upon composition or method of manufacture, the results of tests prove that cement made in this manner is fully equal to any Portland cement made. Tests made in the Imperial Laboratory in Vienna show that a concrete made of one part of slag Portland cement and three parts of sand and broken limestone had a resistance to compression of 4,948 pounds per square inch; while tests on the emery wheel showed a hardness equal to granite.

It has been found that a moderate addition of granulated blast furnace slag improves the quality of this Portland cement, besides reducing the cost of production, which may be explained by the fact that the free lime in the clinker enters into combination with it. Non-granulated slag cannot be used for this purpose, as it does not contain any free silica ready for combination with the lime, as is the case with the granulated slag, where it is formed during the process of granulation. This may be seen from the fact that the non-granulated slag remains almost intact when treated with quicklime and water, whilst granulated slag readily combines with the lime.

Portland slag cement possesses the valuable property of increasing in hardness the older it gets. Thus, a mortar composed of one part of slag Portland cement and three parts of sand showed a tensile resistance of 350 pounds per square inch after 28 days, increasing to 686 pounds after 365 days. Comparative tests of Portland slag cement with ordinary slag cement showed nearly double the strength in favor of the former.

M. de Schwarz discusses the processes of von Forell and of Passow, the former consisting of the burning of the mixed slag and limestone in a rotary kiln and the addition of a proportion of granulated slag before grinding, while the latter uses air-granulated slag, ground without any subsequent mixture. The Passow process is suited only for very basic slags, while that of von Forell relates only to modifications of certain details, and is practically the process already described of mixing the slag and limestone before burning and grinding.

The whole paper is most interesting as serving to differentiate in the public mind the relation between common slag cement and that made in accordance with correct chemical principles. There has been much opposition on the part of dealers in cements as regards the right of makers of slag cements to use the term "Portland" cement in connection with their products; and so far as the ordinary slag cement, made without subsequent vitrification with the added lime, is concerned, this position is undoubtedly correct. When, however, the unburned limestone is added to the slag, and the mixture is carefully burned and ground, the process is practically identical with that used in the standard methods of the manufacture of Portland cement, and both by reason of its chemical composition and its physical properties the product is fully entitled to bear the name "Portland" cement, as analyses and tests have demonstrated.

RADIO-ACTIVE SUBSTANCES.

AN HYPOTHESIS AS TO THE SOURCE OF THE ENERGY LIBERATED BY RADIUM AND SIMILAR SUBSTANCES.

Prof. J. J. Thomson—Nature.

THE remarkable discoveries in the field of radio-activity which have been made by M. Becquerel, M. and Mme. Curie, and other investigators, have been followed in these columns, and very recently the phenomenon of the continuous emission of heat by salts of radium was commented upon. This phenomenon, apparently contradictory to our ideas of physical laws, has given rise to a variety of hypotheses as to the nature of the processes by which radium and similar substances are able to give out energy for an indefinite period.

It has been suggested that radium may draw upon the kinetic energy due to the molecular motions of air. The radium atoms may be so constituted that they can abstract kinetic energy from the rapidly moving air molecules, and at the same time not give up any of their own energy to the slowly moving molecules. But it is hard to see how this hypothesis can explain the action of radium in melting a block of ice. The radium is placed in a closed cavity in the block of ice, and, according to the above hypothesis, the combined energy of the radium and the air in the cavity will not change, for any energy gained by the radium must be lost by the air. The ice, however, is melted, and the radium is clearly able to supply the energy needed for this action.

It has been also suggested that the air is traversed by a very penetrating kind of Becquerel radiation, and that it is the absorption of this radiation that furnishes the energy to the radium. Experiments have shown that the ionisation of a gas inside a closed vessel is diminished by immersing the vessel in water, suggesting that at least part of the ionisation of the gas is caused by a radiation which can penetrate the walls of the vessel, but which is stopped by the water. In order, however, that radium should possess the heating effects which have been observed, its absorption of this radiation must be far greater than that observed in the case of experiments with other metals.

It is possible that this may be the case, but a more reasonable hypothesis has been offered by Prof. J. J. Thomson, in a recent issue of *Nature*. He thinks "that the absence of change in radium has been assumed without sufficient justification; all that the experiments warrant us in concluding is that the rate of change is not sufficiently rapid to be appreciable in a few months. There is, on the other hand, very strong evidence that the substances actually engaged in emitting these radiations can only keep up the process for a short time; then they die out, and the subsequent radiation is due to a different set of radiators. Take, for example, Becquerel's experiment when he precipitated barium from a radio-active solution containing uranium, and found that the radio-activity was transferred to the precipitate, the solution not being radio-active; after a time, however, the radio-active precipitate lost its radio-activity, while the solution of uranium regained its original vigor. The same thing is very strikingly shown by the remarkable and suggestive experiments made by Rutherford and Soddy on thorium; they separated ordinary radio-active thoria into two parts, transferring practically all the radio-activity to a body called by them thorium X, the mass of which was infinitesimal in comparison with that of the original thoria; the thorium X thus separated lost in a few days its radio-activity, while the original thoria in the same time again became radio-active. This seems as clear a proof as we could wish for that the radio-activity of a given set of molecules is not permanent. The same want of permanence is shown by the radio-active emanations from thorium and radium, and by the induced radio-activity exhibited by bodies which have been negatively electrified and exposed to these emanations or to the open air; in all these cases the radio-activity ceases after a few days. I have recently found that the water from deep wells in Cambridge contains a radio-active gas, and that this gas, after being liberated from the water, gradually loses its radio-activity; the radio-activity of polonium, too, is known not to be permanent.

"The view that seems to me to be suggested by these results is that the atom of radium is not stable under all conditions, and that among the large number of atoms contained in any specimen of radium, there are a few which are in the condition in which stability ceases, and which pass into some other configuration, giving out as they do so a large quantity of energy. I may, perhaps, make my meaning clearer by considering a hypothetical case. Suppose that the atoms of a gas X become unstable when they possess an amount of kinetic energy 100 times, say, the average kinetic energy of the atoms at the temperature of the room. There would, according to the Maxwell-Boltzmann law of distribution, always be a few atoms in the gas possessing this amount of kinetic energy; these would by hypothesis break up; if in doing so they gave out a large amount of energy in the form of Becquerel radiation, the gas would be radio-active, and would continue to be so until all its atoms had passed through the phase in which they possessed enough energy to make them unstable; if this energy were 100 times the average energy it would probably take hundreds of thousands of years before the radio-activity of the gas was sensibly diminished. Now, in the case of radium, just as in the gas, the atoms are not all in identical physical circumstances, and if there is any law of distribution like the Maxwell-Boltzmann law, there will, on the above hypothesis, be a very slow transformation of the atoms accompanied by a liberation of energy. In the hypothetical case we have taken the possession of a certain amount of kinetic energy as the criterion for instability; the argument will apply if any other test is taken.

"It may be objected to this explanation that if the rate at which the atoms are being transformed is very slow, the energy liberated by the transformation of a given number of atoms must be very much greater than that set free when the same number of atoms are concerned in any known chemical combination. It must be remembered, however, that the changes contemplated on this hypothesis are of a different kind from those occurring in ordinary chemical combination. The changes we are considering are changes in the configuration of the atom, and it is possible that changes of this kind may be accompanied by the liberation of very large quantities of energy. Thus, taking the atomic weight of radium as 225, if the mass of the atom of radium were due to the presence in it of a large number of corpuscles, each carrying the charge of 3.4×10^{10} electrostatic units of negative electricity, and if this charge of negative electricity were associated with an equal charge of positive, so as to make the atom electrically neutral, then if these positive and negative charges were separated by a distance of 10^{-8} cm., the intrinsic energy possessed by the atom would be so great that a diminution of it by 1 per cent. would be able to maintain the radiation from radium as measured by Curie for 30,000 years.

"Another point to be noted is that the radiation from a concentrated mass of radium may possibly be very much greater than that from the same mass when disseminated through a large volume of pitch blende; for it is possible that the radiation from one atom may tend to put the surrounding atoms in the unstable state; if this were so, more atoms would in a given time pass from the one state to the other if they were placed so as to receive the radiation from their neighbors than if they were disseminated through a matrix which shielded each radium atom from the radiation given out by its neighbors."

These considerations are highly interesting, not only as an explanation of the behavior of radium, but as showing that vast amounts of energy may be due to the inherent motions and configurations of the molecules and atoms of substances, energy which at present is beyond our reach, but which we may yet learn how to control and use.

THE DECAY OF METALS.

A STUDY OF THE NATURE AND CAUSES OF THE DETERIORATION OF METALS IN ENGINEERING STRUCTURES.

Institution of Civil Engineers.

PROBABLY no one department of the study of materials of construction has received more attention of late than that of their strength or resistance to the various stresses occurring in engineering structures. Testing machines of great ingenuity and large cost have been made, and delicate recording devices produced to be used in connection with scientific investigations, while a great international society has been formed to unify methods of using such apparatus, and to effect interchange of knowledge upon the subject. In addition to all this scientific study of the strength of materials, the practical employment of testing machines by the engineer, the manufacturer, and the contractor has continually increased, so that there is no doubt that more is known at the present time about the strength of the materials entering into a given structure than ever before.

There is an important side to the question of the strength of materials, however, which has not received the attention which it has deserved, namely, the permanence of the resistance with the lapse of time. It is most desirable to know the resistance of the original structure, but it is equally important to know the nature and extent of its deterioration. We are all familiar with the phenomena of the decay of wood and of other organic substances, but the nature of the decay of metals is less frequently considered. It is this question of the deterioration of metals which forms the subject of a paper presented before the Institution of Civil Engineers by Messrs. J. T. Milton and W. J. Larke, and the value of the information and the importance of the conclusions renders an abstract desirable.

It is generally understood that iron and steel are liable to deterioration by corrosion or rusting, and hence various methods of protection of such metallic surfaces have been employed. When, however, extreme durability is desired, copper, brass, gun-metal, and other alloys have been chosen, but even these metals have been found to corrode or decay under seemingly obscure conditions.

Among the examples discussed in the paper may be enumerated: the pitting of the tubes of marine surface condensers; the decay of brass bolts in composite vessels; the decay of the brazing metal in copper steam pipes; the deterioration, as distinguished from oxidation, of cast iron used for parts of marine engines; and the decay of some propellers made of special bronzes when fitted to copper-bottomed vessels.

One of the most important questions is that relating to the deterioration of the tubes of surface condensers. These have been made of copper-zinc alloys, with especial view to durability, but in some cases they are found eaten into holes, and in other instances to suffer a general decay while retaining their original form. This deterioration, in the case of copper-zinc alloys, appears to be due to the loss of zinc, probably due to galvanic action, the remaining metal becoming a spongy mass of copper. This action takes place, not only when the metal is exposed to heat and moisture, but also under less obvious circumstances. Thus hard drawn spring-wire of brass, when hung up in coils in a storeroom, has been found after the lapse of time to become almost rotten and altogether useless for springs, the zinc having segregated from the copper to a large extent.

Such action naturally lends itself to study by the methods of metallography, and Professor Arnold has shown that some copper-zinc alloys appear to possess a duplex structure, both constituents being definite chemical compounds of copper and zinc, but one richer in copper than the other, these having a galvanic action upon each other whereby the zinc is separated. In the case of the deterioration of cast iron a similar action occurs, the iron gradually disappearing and the graphitic carbon remaining.

When the metal is of homogeneous composition the causes for decay are less obvious, but they may frequently be found in local impurities. Thus, condenser tubes, supposed to consist of an alloy of copper and zinc only, or of copper, zinc and tin, really contain other elements, commercial copper and zinc rarely being pure. If the impurities are uniformly distributed through the mass of the alloy it may still be homogeneous, but the tendency to segregation will produce a lack of uniformity, causing local galvanic action and consequent pitting.

If such segregation occurs during the solidification of the alloy in casting, the impure portions are subsequently drawn out into elongations in conection with the manufacture of the tubes, thus preparing the way for seamy corrosion. A number of experiments have been made to investigate such action, the conclusions being that the presence of lead increases the liability to corrosion, while the addition of a small proportion of tin gives material protection, especially against the action of sea water.

The general conclusions given in the paper, as the result of numerous experimental investigations are, in abstract:

Decay is more frequent in metals which have a duplex or complex structure than in those which are comparatively homogeneous. It is due to a slower action than that causing ordinary corrosion; a part only of the constituents being attacked, while in corrosion all the material is affected. Both decay and corrosion may result from chemical action alone, or from chemical and electrolytic action combined. Pitting, or intense local corrosion, is often due to local segregation of impurities in the metal, but it may also be caused by local irregularities of structure, producing local irregularities in the distribution of galvanic currents.

In the case of brass exposed to the action of sea water, tin is distinctly preservative, while lead and iron are both injurious, rendering the brass more readily corrodible, so that the percentage of the latter metals should be kept as low as possible. Smoothness of surface also reduces the liability to corrosion, and hence it is desirable that the cylinders from which tubing is drawn should be smoothly bored inside.

Experiments in electrolysis show that very minute currents may produce very severe corrosion and decay. All electric cables or other sources of galvanic action should therefore be most carefully insulated, or where such insulation is not possible, the currents should be neutralized by the application of zinc plates in the circuit so arranged that they are negative to both of the other metals.

While these investigations relate mainly to the decay of copper-zinc alloys, and those used principally for tubes exposed to the action of sea water, yet the lesson may be extended broadly to other materials and various applications. It is not sufficient to know that a metal originally possesses a certain general composition and a fairly well determined strength. The effects of the presence of impurities must be studied, as well as the action of elements to which it may be exposed. Deterioration should be considered, and, if possible, prevented; or, if prevention is impracticable, this fact should be taken into account in the determination of dimensions, and in the limitations to be imposed in actual service.

IMPROVEMENTS IN RAILWAY SHOP ORGANIZATION.

BETTER TOOLS AND BETTER PRACTICE BRING BETTER WORKMEN AND AN ADVANCED MORAL TONE.

Charles H. Fitch—The Railway Master Mechanic.

A SERIES of papers on Roailroad Shop Tools, by Mr. Charles H. Fitch, appearing in the *Railway Master Mechanic,* present under a somewhat specialized title certain suggestions which are highly interesting and widely applicable to the conditions to be observed throughout the mechanical industries generally. "We cannot," says Mr. Fitch, "separate from shop tools those whose brains they empower and whose hands they sometimes supplant—namely, the men. Nor can we fail to consider the inter-relations of shop tools, their encroachments upon one another, and the whole combination of appliances, moving or static, which enables us to consider a shop equipment as one comprehensive machine operated by an organization of men."

"In 1881 I was at the Dickson Locomotive Works, looking for data and improvements in shop tools. A foreman there said: 'In 1870 we had fewer tools and about three times as many men in the shops to do the same work.' Here we are in 1903. Vastly more and better tools, more shops, better men. I venture to state my belief that if we could measure off an average man from the shops of 1870 against the average man of the shops of to-day we would find the latter heavier, larger and better built and nourished in body, and with a distinctly heavier and better organized brain."

It is not yet quite the golden age. "The fact remains," says Mr. Fitch, "that we have a great deal that is coarse, crass and unintelligent to deal with, and that there remain unfair spots in administration as there are hard spots that interfere with the turning of work in the wheel lathe. But a man who has been going about machine shops for thirty years knows that there are facts of moral atmosphere as well as machine improvement, that present-day shops are head and shoulders over the old shops. When I first came west the first shop I struck (not a railroad shop) was one babel of profanity from morning till night; intemperance and scamping tricks were usual. and the prevailing idea seemed to be to curse the work through somehow. It was a big shop, too. I do not need to go to that shop to-day to testify that no such conditions prevail. I know that it is clean-mouthed, that the curses have given place to quiet and effective thought. I know that the best man is not the biggest drinker, kept because brains were so scarce that even an intoxicated brain could not be let go. I know that temperance is the invariable rule and that there is more gentleness and higher intelligence in every rank of work from manager to helper. I know these things without going to verify them because I know the old conditions would not be tolerated in any American shop. I know that this shop, now much bigger than before, is 'right down in front' with modern shop tools and system, and is itself one of the largest producers of labor-saving machine tools for railroad shops. The rest follows. Not more surely does freedom (under constitutional law) follow the flag, than do good morals follow improvements in shop tools.

"The importance of this can be realized by looking back to peon labor, the labor of the brutal man requiring the urgency and restraint of force to maintain the simplest continuous work. Fine tools are not possible with such men, and while harsh measures can control them their work is low grade. There is something like tempering steel in men, a critical point between force and intelligence. That critical point was once thought to be the limit of work, but we have found that we can go beyond it securely and produce better results. The critical point with men comes when they are tempered to such fiber that they are too shrewd to be safely governed by force and too stupid to be allowed to govern themselves by intelligence. In the future government by intelligence will prevail and improved shop tools will strengthen it."

So much for the moral and sociological expression of the change; its physical—or, if you please, its industrial—result is epitomized in the fact cited by Mr. Fitch that "it takes but a few more men a year, on the average, to build the modern locomotive than the ancient one." But a few more human labor hours in the 110-ton decapod than in the 7-ton "Old Ironsides." And because of that, thousands of locomotives built and tens of thousands used in 1903 for every one in 1832—hundreds of thousands of men profitably and productively employed now, where there was scarcely room for scores then. And yet "organized labor" too often seems able to see only the reduction of labor hours on the single job, and to have no vision of the vast demand for vastly more labor, and higher and happier labor, which every such reduction brings. Their perception of it lies at the end of a long era of education, which is but begun. That they have as yet so little understanding is often cause of distress, but never reason for despair.

THE VIAUR VIADUCT.

A DESCRIPTION OF A GREAT STEEL RAILWAY ARCH OVER A RIVER IN THE SOUTHERN PART OF FRANCE.

Le Génie Civil—Bulletin of the International Railway Congress.

A FEW months ago, the Midi Railway opened a line from Carmaux to Rodez, in the southern part of France, which has been under consideration since 1876, and which is of great commercial importance, as it gives an outlet toward the center of the country for the extensive mineral wealth of the Carmaux district. The construction is of a difficult character, as the line traverses the high Rouergue plateau, and crosses several deep ravines, the most important of the latter being the valley through which the Viaur river flows. This valley was the chief obstacle to be overcome, and it was necessary to build a great viaduct to cross it.

After several tentative plans for this structure had been drawn and discussed, a competition was instituted, as a result of which seven designs were submitted by some of the leading bridge companies of France. Several of these designs were for viaducts consisting of trusses supported on either high metallic towers or masonry piers. Another design showed a rigid steel arch, hinged at the center, and serving as a support for the middle trusses of the viaduct, the other trusses being carried on metallic towers. Still another plan called for two cantilevers, connected by a short truss at the center of the viaduct.

The design which was finally adopted, however, was a radical departure from any of the others, and has, in fact, set a new fashion in arched bridges. It may be described, in short, as a cantilever arch. Each half of the central span is balanced by another half arch on the approach side, the extremities of these side arches not resting on the masonry abutments, but being connected with them by means of short lattice trusses. The central arch is pivoted at the abutments and hinged at the key, and the side arches are hinged at their connection with the end trusses, which take up any vertical movement at that point due to temperature variations or moving loads.

This design was submitted by the Société de Construction des Batignoles, and is due to M. Bodin, its consulting engineer, who is also professor at the Ecole Centrale des Arts et Manufactures and president of the Société des Ingénieurs Civils de France, and to M. Godfernaux, the chief engineer of the company. Descriptions of the completed viaduct have appeared recently in the *Génie Civil,* written by M. Henry Martin, and in the *Bulletin of the International Railway Congress,* from which our account is taken.

The original design was for a central span of 250 meters (820 feet) but this was modified, owing to a change in the Government regulations and to the advice of the Government engineer, so that the design, as finally adopted, provided for a central arch, of 220 meters (722 feet) with a rise of 53.73 meters (176 feet). As before stated, this central span is hinged at the key, and each of the half arches of which it consists, which rest on pivots at the masonry piers, is balanced on the other side of these piers by another half arch, whose length is 69.6 meters (228 feet). The outer extremity of this cantilever is connected to the masonry abutment by an independent steel girder of an open lattice type, 25.4 meters (83 feet) long, which forms a junction between the fixed part and the movable part of the structure. The horizontal distance from the masonry pier to the abutment at either end is therefore 95 meters (312 feet) and the total length of the metallic part of the structure is 410 meters (1,345 feet). The masonry portion of the viaduct is 21 meters (69 feet) at one end and 29 meters (95 feet) at the other, so that the length over all of the entire structure is 460 meters (1,510 feet). The height of the rails above the bed of the stream is 116 meters (381 feet).

The viaduct carries a single track running on top of the straight upper booms The lower booms are polygonal, with straight members of varying lengths between the piers and the center. The upper and lower booms are connected together by diagonals and verticals, with no redundant members. In order to assure complete stability, even in the highest winds, the two ribs which compose each half of the arch have an inclination of 1 in 4, the distance between their centers at the top just over the masonry piers being 5.89 meters (19 feet) and the bottom, 33.39 meters (110 feet) which is, of course, the distance between the pivots on the piers. These two main ribs are rigidly connected together, and are stiffened both at the verticals and at some of the diagonals by a system of wind-bracing consisting of cross girders and cross bracing, and the cross girders carrying the rails also act as stiffners. The principal diagonal and vertical members are latticed columns, enlarged at the middle in order to resist compressive stresses better.

The floor is formed with cross-girders attached to the verticals of the main girders. The cross girders are connected by longitudinal beams and on these rest Z beams, laid transversely and riveted to the main and secondary longitudinals. The flooring is also stiffened by three rows of longitudinal Z beams placed underneath and riveted to each of the transverse Z beams. The rails are double-headed and rest in chairs placed on the stringers which are carried by the transverse Z beams. There is a footpath on either side of the track, consisting of corrugated iron plates 80 centimeters (2 feet, 7½ inches) wide. Outside the footpaths are steel railings 1.8 meters (6 feet) high, and strong enough to hold locomotives and cars in case of derailment. The railing is formed of main and secondary posts and of several horizontal bars.

The key pin is a forged steel cylinder 95 centimeters (3 feet, 1 inch) long, and turned to a diameter of 20 centimeters (7⅞ inches) on which bear two cast-steel saddles fixed to the ends of the half arches, the diameter of the saddles being 20.5 centimeters (8 1-16 inches). Both ends of the pin pass through eyes in the ends of bars which are riveted to the extremities of the half arches, in order to hold the pin in case the pressure at the center is abnormally reduced. There is very little probability of this occurring, as the design gives a minimum thrust on the pin of 151 tons.

The material used for the structure is mild steel, except that the end trusses, the flooring, the rivets and some other parts are of iron. The total weight of the metallic structure is about 3,500 long tons, equivalent to about 8,400 kilograms per running meter (5,640 pounds per running foot). The total cost, including that of the masonry, is estimated at 2,700,000 francs.

The side arches and the end trusses were erected on timber scaffolding. The cantilever arches were then loaded and anchored and the erection of the two halves of the central arch was carried on with travelers, without any falsework. Near the site of the bridge there was a yard where the parts of the structure were made up into the largest pieces that could be handled by the traveler, and in some cases, important joints were riveted up experimentally.

The final design was approved of in April, 1896, the erection of the metallic structure was begun about the middle of 1898, and the inauguration of the viaduct took place in October, 1902.

When finished, the bridge was subjected to severe tests, with locomotives weighing 73 tons, tenders weighing 26.4 tons, and cars weighing 22 tons apiece. With two locomotives placed head to head at the center of the arch, there was a deflection of only 41 millimeters, which was less than that calculated. Trains with two locomotives and twenty cars, representing a total weight of 639 tons, were run over the structure at speeds of 20 and 40 kilometers (12½ and 25 miles) per hour, and caused only slight deflections at the key and at the ends of the cantilevers.

The span of the great central arch, 722 feet, is exceeded by only one in all the world, the Niagara-Clifton arch, which is 840 feet. But the latter is a comparatively light structure, built for highway and electric tramway purposes, and it has a total weight of only about 2,000 tons, as compared with the 3,500 tons of the Viaur viaduct. The total length of the Niagara-Clifton structure, including the approach spans, is 1,240 feet, and its height above the Niagara river is 185 feet, while the corresponding dimensions for the Viaur viaduct are 1,345 feet and about 380 feet. Among the other great steel arches of the world may be mentioned the Niagara railway arch, with a central span of 550 feet, the Müngsten viaduct in Germany, 525 feet, and the Garabit viaduct in France, 541 feet. In spite of its colossal dimensions, the Viaur viaduct presents a singularly light and graceful appearance, and adds to the beauty of the landscape in which it is set.

THE VALTELLINA RAILWAY.

AN ELECTRIC PASSENGER AND FREIGHT RAILROAD IN NORTHERN ITALY, OPERATED ON THE GANZ THREE-PHASE SYSTEM.

Elektrotechnische Zeitschrift—The Electrician—Zeitschrift des Oesterreichischen Ingenieur- und Architekten-Vereines.

EVER since the Valtellina electric railway was first planned, it has excited the interest of electric engineers in all parts of the world, as it is the principal application, so far made, of high-tension three-phase currents to traction work. The Ganz Company, of Budapest, whose system was adopted for this road, have been experimenting with three-phase current on railways for a number of years, and before the road was taken over by the owners thorough tests, extending over a considerable period, were made. These proved satisfactory, and the road has now been in successful operation for several months, so that an estimate of the value of the system can be made. It may, therefore, be of interest to review some accounts of this railway and its equipment, which have appeared in recent issues of the *Elektrotechnische Zeitschrift* and the *Zeitschrift des Oesterreichischen Ingenieur- und Architekten-Vereines,* by Herr Eugen Cserháti, one of the officers of Ganz & Co., and in *The Electrician.*

The Valtellina road runs from Lecco, near the southern end of Lake Como, along the eastern border of the lake to Colico, a distance of about 39 kilometres. Here it branches, one line going north about 26½ kilometers to Chiavenna, and another east, up the valley of the Adda, about 41 kilometers, to Sondrio, the total length of the road being a little over 106 kilometers, or 66 miles. It was formerly a regular steam railway, doing a large passenger and freight business, the passenger traffic being particularly heavy in the summer months, as this road is on the line of travel for tourists between the Engadine and the Tyrol and Lombardy. There is also considerable local traffic, both passenger and freight, manufactures of silk and cotton and agricultural products making up the bulk of the latter. It will thus be seen that the service required is that of a first-class railway.

The line is owned by the Italian Government and operated by the Adriatic Company, but the electrification of the road was undertaken by a special company, which was formed to develop the possibilities of electric traction on Italian railways.

The power is derived from the Adda river. A movable dam was built, and part of the stream diverted through a 4.8-kilometer canal to the power station at Morbegno. The effective head varies from 90 to 100 feet, and the minimum horse power available is 7,500. In the power house are three 2,000-horse-power Francis reaction turbines, with horizontal axes, directly connected to three-phase generators.

The generators furnish current at a voltage of 20,000, with a frequency of 15 periods per second. Their normal capacity, with a power factor of 0.7, is 1,050 kilowatts, but they can be heavily overloaded without excessive heating, and can even stand a short circuit for two minutes, without injury. With constant speed, the voltage varies 15 per cent. for a change from no load to one of 1,500 horse power, and when the full load is suddenly taken off, the rise in voltage is not more than 10 per cent. The weight of each generator is 69,300 kilograms, the rotating parts alone weighing 43,800 kilograms.

After leaving the switchboard, which is very carefully arranged to secure complete safety for the operatives, the high-tension line goes first to the railway station at Morbegno. Here it divides, one branch, consisting of three bare copper conductors, each 7 millimeters in diameter, running about 20 kilometers towards Sondrio, and the other branch, with three 8-millimeter conductors, going to Colico. At this point the line branches again, one part going toward Lecco and the other toward Chiavenna. The conductors are carried on red larch poles, with a minimum diameter of 0.3 meter at the butt and 0.25 meter at the top. The primary wires are placed one above the other, at intervals of 60 centimeters, on porcelain insulators having four petticoats, which are fixed to iron brackets on the outer side of the poles. For the most part, the primary conductors are carried on the same poles which support the trolley wires, but at tunnels they run outside on independent poles.

There are nine sub-stations, eight of which have each a 300-kilowatt, three-phase, static transformer; and one, at Abbadia, has two such transformers. These stations have two rooms; in the outer one are the conductors and switches and the ventilator for the transformer, and in the inner are the transformer itself and the lightning arresters for the primary and secondary circuits. These transformers reduce the potential to 3,000 volts, at which pressure it is used directly on the trolley wires and in the motors. As the transformers are subjected to a very fluctuating load, they are designed so that they will carry five times their normal load without injury and without excessive drop in voltage.

At present the passenger traffic of the Valtellina road is carried on by motor cars, and the freight hauling is done by locomotives, but it is planned to operate the heavy and high-speed passenger trains also by locomotives which shall be able to haul 250-ton trains up one per cent. grades at speeds of 60 to 70 kilometers an hour, and 400-ton trains at 35 kilometers. The motor cars now in operation weigh 53 tons and can haul from 5 to 7 trailers, with a total weight of 150 tons, up one per cent. grades with a speed of 65 kilometers per hour. There are ten such motor cars, five of them luxuriously fitted for first-class traffic, and five composite passenger cars, for different classes.

The car body rests on two trucks, each of which carries two polyphase motors. One motor on each truck is wound for the working voltage of 3,000, while the other, or low-tension, motor is designed for 300 volts. The latter is an auxiliary motor, which is used only at starting, when ascending heavy grades, and when, on descending grades, energy is being returned to the line. At such times, the two motors are connected in "cascade," as the arrangement is termed, the stator windings of the principal motor carrying the high-voltage current, while its rotor coils are connected to the stator circuit of the auxiliary motor. The rotor of the latter is in circuit with the starting resistance, which consists of a liquid rheostat, in which the resistance is gradually reduced by raising the liquid, in which contact plates are held. The liquid is raised by means of compressed air, and when the plates are fully immersed, the rheostat is short-circuited. At this point, with no resistance in circuit, the motors are running in "cascade" synchronism, which is at half speed. To increase the speed, the auxiliary motor is cut out, and the rheostat connected with the principal motor and gradually short circuited until the principal motor is running without any resistance, when it will be at full synchronism.

There are three definite positions of the controller: the first, when both motors are cut out; the second, when the motors are connected in cascade and the rheostat is in circuit with the auxiliary motor; the third, when the auxiliary motor is cut out, and the rheostat is in circuit with the principal motor. At starting, the controller handle is placed at one of these points, and a stop-cock opened which admits the compressed air to the liquid rheostat. To go from half speed to full speed, the stop-cock must first be closed, then the controller handle is moved to the third position and the air again admitted to the rheostat. The speed at which the water rises in the rheostat can be closely regulated.

An air compressor, driven by an independent motor, supplies the air needed for the operations already described, as well as for the Westinghouse brakes and the whistle. A transformer, with a 100-volt secondary circuit, furnishes the current for the air-compressor motor, as well as for heating and lighting. There is also another lighting circuit on each car, supplied with current from accumulators, in order to provide for any interruption to the main line current.

The two electric locomotives already in service weigh 46 tons apiece, and have four axles, each provided with a 150-horse-power high-tension motor. The cascade arrangement is not used here, and the only synchronous speed is 30 kilometers per hour, which is all that is necessary for freight service.

There is an elaborate system of switching and safety apparatus in the stations, on the line, and on the rolling stock, and the road has been operated without accident since it was opened. In one period of a half-month the number of ton-kilometers was 3,293,254 and the total energy consumed, including all losses, measured at the switchboard of the generating station, was 163,470 kilowatt hours, giving an average of 49.7 watt hours per ton-kilometer.

When steam was the motive power, the number of trains daily was 34, and the train-kilometers run were 898. With electric operation, the corresponding figures are 46 and 1,668. This large increase of traffic shows that the electrification of the road has met with the favor of the traveling public.

CANADA'S MINERAL INDUSTRY.

THE MINING AND METALLURGICAL INDUSTRIES OF CANADA AND NEWFOUNDLAND, AND THEIR FUTURE DEVELOPMENT.

The Canadian Mining Review.

ALTHOUGH Canada is still far behind its great neighbor on the south in material development, it possesses vast natural resources, both agricultural and mineral, which make it potentially one of the richest countries in the world. Its far-reaching forests, its illimitable and fertile prairies, and its immense mineral deposits are sources of wealth which are as yet merely touched, but which will undoubtedly be greatly developed in the future, and will offer large opportunities for a population many times greater than that now within the borders of the Dominion.

In fact, this industrial expansion in many directions has already begun, and two or three great new railway lines are projected which will open up large territories which have hitherto hardly been explored. The mineral production of Canada grows apace, and some figures and comments concerning it, which have appeared in *The Canadian Mining Review,* possess more than a local interest.

In an article by Mr. George Johnson, the Dominion statistician, on "Mineral Production, Canada and the United States," it is stated that in 1901 the total value of the mineral products of Canada, taking round figures only, was $66,000,000, made up of $42,000,000 of metallic and $24,000,000 of non-metallic materials. Compared with the total of the United States for the same period, $1,092,000,000, this does not seem large, but taking the relative populations into account, Canada produced $12.42 per capita and the United States $14.12 per capita, a difference of only $1.70 per head. Seeing that Canada was $6 per head behind the "States" in 1891, this method of comparison shows the Dominion in a much more favorable light.

The metallic products of Canada include antimony, copper, gold, pig iron, lead, mercury, nickel, platinum, silver and zinc. In 1891, the metal output of the United States was 55 times as great as that of Canada, but in 1901 it was only 12½ times as great, and this improvement in Canada's relative position has been made in spite of the very large absolute increase in the figures for the United States. The principal part of the gain for Canada has been in gold, the production of which increased from $930,000 in 1891 to $24,000,000 in 1901. The Klondike region, of course, has contributed largely to this increase. The production of iron and steel has also grown greatly in the past ten years, with good prospects of a still brighter future. In the production of nickel Canada surpasses not only the United States, but all other countries. The total nickel product of the world for 1901 was $7,750,000, of which Canada's contribution was $4,600,000.

Canada's non-metallic mineral products include coal, petroleum, building materials, abrasives, chemicals, pigments, and other miscellaneous materials. Among these may be mentioned asbestos, of which 40,000 tons, valued at $1,260,000, were produced in 1901.

Newfoundland, in the popular mind, is generally thought of as a land of fogs, whose population ekes out a precarious livelihood by fishing. But as a matter of fact, it is a country whose natural resources, while still largely latent, possess great possibilities of development. The total value of its mineral products for 1902 amounted to over $1,200,000, according to figures given in an article on "Mining in Newfoundland," by Mr. J. P. Howley, and taken from his annual report to the Minister of Agriculture and Mines. Iron ore was the most valuable product, and copper ore, pyrites, slate, brick, paving stone, granite and other materials helped to swell the total. Boring operations for petroleum have resulted favorably, and the discovery of free gold has given a stimulus to the search for the precious metal, resulting in the finding of several rich specimens. Two gold quartz mines are already in operation.

But in spite of what has already been done in developing Canada's mineral resources, far more remains to be accomplished. This is well brought out in an article by Mr. Bernard MacDonald, on the "Mining Possibilities of the Canadian Rockies." By the "Rockies" is here understood all the mountainous region lying between the great central plain of the North American continent and the Pacific Ocean. It is stated that the Mexican "Rockies," which have an axial length of about 1,700 miles, have produced an average of $3,143,000 of the precious metals per mile, and that the United States "Rockies," 1,300 miles in length, have produced $3,462,000 per mile on the average, while the 1,600 miles of the Canadian "Rockies" have so far produced only an average of $104,000 per mile. The geological features of the Rocky Mountains in Canada are very similar to those of the parts of the chain in the United States and Mexico, and it is but reasonable to suppose therefore that the Canadian "Rockies" may yet produce as much of the precious metals as the western parts of the "States" and Mexico. One reason for the backwardness of Canada in this respect may be found in her climatic conditions, but these are not insuperable, as has been strikingly shown by the successful working of the Klondike placers. And if mineral veins are discovered, even in Arctic regions, they can be exploited underground with comparatively little interference by the weather, however severe.

In order to develop the latent possibilities of the Canadian "Rockies," Mr. MacDonald proposes that comprehensive, systematic prospecting should be undertaken by a large corporation, or, better still, by the Dominion Government itself. Any mineral deposits discovered by these prospecting parties would be located for the benefit of the corporation which financed them, with some claims reserved for the members of the party. If the Government undertook the work, then the members of the prospecting party which made a discovery would have the privilege of locating a couple of claims apiece, while all the rest of the territory would be thrown open to the general public.

By means of such systematic exploration on a large scale, results would be much more quickly and certainly arrived at, and the whole country would be greatly benefited by the largely increased production of the precious metals thus discovered.

THE ENGINEERING INDEX

"THE ENGINEERING INDEX IS THE KEYSTONE OF APPLIED SCIENCE"

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Bridge Pavement.

Steel Underflooring and Wood Block Pavement for the Roadways of the Williamsburg Bridge. Gives sections showing construction, with extracts from specifications in regard to treatment for the prevention of oxidation, and requirements for materials and workmanship in paving. 1500 w. Eng News—May 21, 1903. No. 55323.

Canal Bridges.

The Weight of Iron Bridges Carrying Canals (Ueber das Eigengewicht Eiserner Brückenkanäle). Victor Waniek. The calculation of the weights of the bridges which form part of canals, and some details of construction, with tables and curves. 1 Plate. 1000 w. Oesterr Wochenschr f d Oeffent Baudienst—March 21, 1903. No. 55474 D.

East River Bridge.

Erection of the Manhattan Approaches to the Williamsburg Bridge. An outline of the design and construction of this great engineering work, with report of the progress on the viaduct approach, and related matters of interest. 1200 w. Eng Rec—May 9, 1903. No. 55146.

We supply copies of these articles. See page 638.

Europe.

Some Modern Types of Swiss and German Bridges. Gives illustrations of some artistic bridges, with descriptive notes. 900 w. Sci Am Sup—May 23, 1903. No. 55316.

Gokteik Viaduct.

The Gokteik Viaduct (Der Gokteik-Viadukt in Indien). Hr. Frahm. An illustrated account of this great steel railway viaduct in Burma, built by the Pennsylvania Steel Co. 2200 w. Stahl u Eisen—May 1, 1903. No. 55435 D.

Kew.

The King Edward VII. Bridge at Kew. Brief account of the earlier structures occupying the site of this new bridge, with many illustrations and description of the construction of this finely proportioned three-span structure. 2700 w. Engng—May 15, 1903. Serial. 1st part. No. 55369 A.

Mississippi.

The Rigolets Bridge. Brief description, with illustrations, of a structure to replace a bridge about 25 years old, on the New Orleans-Mobile line of the Louisville and Nashville. The structure is interesting on account of its length, and the use of creosoted timber piers. 300 w. R R Gaz—May 15, 1903. No. 55213.

Ornamental.

Ornamental Bridges in a Private Park. Illustrations of two bridges on a private estate in New Jersey, with description. 1300 w. Eng Rec—May 23, 1903. No. 55354.

Viaur Viaduct.

The Viaur Viaduct (Le Viaduc du Viaur sur la Ligne de Carmaux à Rodez). Henry Martin. A very well illustrated description of this great steel railway viaduct in the southern part of France, which includes an arch with a span of 220 meters. Serial. 2 parts. 2 plates. 7000 w. Génie Civil—May 2 and 9, 1903. No. 54896 each D.

The Viaur Viaduct on the Line from Carmaux to Rodez. An illustrated description of this great steel railway viaduct in the southern part of France, which includes an arch with a span of 220 metres. 3200 w. Bul International Ry Cong—April, 1903. No. 55380 E.

CANALS, RIVERS AND HARBORS.

Barge Canal.

The Lake Ontario Route for a Barge Canal. Editorial discussion of this route, giving the report of Mr. William Pierson Judson. 1700 w. Eng News—May 14, 1903. No. 55219.

British Canals.

The Canal System of Britain. H. E. P. Cottrell. Describes the present condition of the canals and navigations, briefly reviewing their history and working, and giving tabulated information of interest. Map. 5400 w. Trac & Trans—May, 1903. No. 55276 E.

Chaudiere Falls.

The Water Power Development at Chaudiere Falls, P. Q. A finely illustrated descriptive account of the plant and construction work. 6000 w. Eng News—May 7, 1903. No. 55138.

Coal Shipping.

See Mining and Metallurgy, Coal and Coke.

Corinthian Canal.

The Corinthian Canal. Gives an outline of the history of this project, describing important features and discussing why it is almost deserted by foreign craft. Ill. 1500 w. U S Cons Repts, No. 1635—May 1, 1903. No. 54989 D.

Drainage.

Red River Valley Drainage Ditches; Their Repair and Maintenance. Prof. W. R. Hoag. Discusses some things to be considered in the construction of ditches for the removal of excess of water, especially referring to this valley in Minnesota. Ill. 3500 w. Jour Assn of Engng Socs—April, 1903. No. 55-293 C.

Dredges.

The New 30-in. Hydraulic Dredge for the Port of Portland, Oregon. Two-page plate, illustrations and description of one of the most noteworthy dredges yet built, its construction and operation. 4500 w. Eng News—April 30, 1903. No. 55086.

A Small "Home-Made" Dipper Dredge or Steam Shovel. Illustrated detailed description of a power excavator very useful where it is difficult and expensive to take a dredge or steam shovel. 1000 w. Eng News—May 14, 1903. No. 55217.

The 15-Cu. Yd. Dipper Dredge for the New York Harbor Improvements. Illustrated description of the construction and operation of the largest and most powerful dipper dredge in the world. 600 w. Eng News—May 14, 1903. No. 55218.

Hudson River.

Operations of the Hudson River Water-Power Company. Charles E. Parsons. An illustrated description of the plant at Spier Falls and its construction. Power will be transmitted to surrounding cities and villages. 5500 w. Trans Am Inst of Min Engrs—Feb., 1903. No. 55383 C.

Locks.

Electrically Operated Locks on the River Seine. Daniel Bellet. Illustrates and describes the locks and barrage at Amfreville-Poses, recently built to improve the flow of the river and insure a 10 ft. 6 in. minimum depth of water between Rouen and Paris. 1900 w. Trac & Trans—May, 1903. No. 55278 E.

The Cardot Oscillating Lock (Ecluse Oscillante, Système Cardot). A. Morel. An illustrated description and a theoretical discussion of a canal lock which consists of a tank, with watertight compartments, moving on a hinge. Serial. Part 1. 2500 w. Rev Technique—May 10, 1903. No. 55424 D.

Mount Rainier.

Electric Power Plant Below Mount Rainier. Earl Mayo. Brief account of a plant under construction which will utilize a glacier flow on the Pacific coast, and deliver electric energy to the cities of Washington. 1300 w. Sci Am—May 23, 1903. No. 55311.

Panama Canal.

The Panama Canal: The Dual Versus the Single-Lake Project. Gen. Henry L. Abbot. Summarizing the objections to the high-level plans advanced by the Isthmian Canal Commission and by Mr. George S. Morison, and the superior advantages of the project of the Comité Technique for a lower summit at Lake Bohio and a second dam at Alhajuela. The article is a reply to one by Mr. Morison in The Engineering Magazine for January, 1903. 2400 w. The Engineering Magazine—June, 1903. No. 55492 B.

The Advantages of Lake Bohio at the Higher Level. George S. Morison. A brief expression of the conclusions which led the Isthmian Canal Commission to advocate plans for the Panama Canal with a high summit level, and an answer to the principal criticisms of those plans, especially as to the Bohio Dam. Ill. 900 w. The Engineering Magazine—June, 1903. No. 55493 B.

The Panama Canal (Der Panama-Kanal). W. Kaemmerer. A general review of the Panama Canal and the principal plans for its construction, with maps and illustrations. 3500 w. Zeitschr d Ver Deutscher Ing—May 9, 1903. No. 55450 D.

St. Francis River.

An Estimate of the Discharge of the St. Francis River. K. M. Cameron. A summary of the methods employed and of the results obtained by the students of McGill University in the determination of the discharge of the river by means of current meters. Ill. 2800 w. Can Soc of Civ Engrs—Adv proof—April, 1903. No. 55169 D.

CONSTRUCTION.

Coal Pocket.

Foundation for Coal Pocket at Lincoln Wharf, Boston Elevated Railway Co. Robert B. Davis. An illustrated description of the foundation or wharf under an up-to-date coal pocket. 5 plates. 3000 w. Jour Assn of Engng Socs—March, 1903. No. 55160 C.

Concrete-Steel.

A Tall Concrete-Steel Office Building. An illustrated detailed description of the Ingalls building, Cincinnati, Ohio. 3200 w. Eng Rec—May 23, 1903. No. 55353.

Concrete Structures.

A New System of Finishing Concrete Structures. Describes a method by which a fine concrete facing when roughened is made to have the appearance of stone. Ill. 1100 w. Eng News—May 21, 1903. No. 55320.

Dams.

Report on Bad Foundations Beneath the Core-Wall of the Earth Portion of the New Croton Dam. A report by Wm. R. Hill in regard to the disintegration of the limestone foundations beneath the core-wall of the earth section. Ill. 700 w. Eng News—May 14, 1903. No. 55221.

The Problem of the Great Croton Dam—New York City Water Supply. An illustrated article explaining the defects which have caused public alarm, and what has been done to remedy them. 1400 w. Sci Am—May 30, 1903. No. 55523.

The Wigwam Reservoir Masonry Dam of the Water-Works of Waterbury, Conn. R. A. Cairns. An illustrated account of the construction and the growth of the city that made the work necessary. 2400 w. Eng News—May 7, 1903 No. 55140.

Docks.

The Construction of Docks. Alexander MacLachlan. An article dealing with typical forms of modern docks and discussing details. Ill. 3300 w. Feilden's Mag—May, 1903. Serial. 1st part. No. 55376 B.

Fireproofing.

The Economics of Construction. John Lyman Faxon. The first of a series of papers urging a departure from the present system of steel framing and the adoption of solid masonry construction, and burnt clay products, claiming not only greater endurance, but less cost. 2800 w. Br Build—April, 1903. Serial. 1st part. No. 55030 D.

Foundations.

Grillage vs. Concrete Foundations. From a paper by J. C. Hain, read before the Iowa Ry Club. The relative merits of grillage on a pile foundation and the method of surrounding the heads of piles with concrete several feet below the cut-off. 1700 w. Ry & Engng Rev—May 23, 1903. No. 55343.

Grain Elevators.

Grain Elevators. An illustrated article considering the various types, new and old, and giving some loss figures from fires. 2800 w. Ins Engng—May, 1903. No. 55303 C.

Hangers.

Points that Should be Considered in Selecting or Designing Joist and Wall Hangers. F. E. Kidder. An illustrated article giving information of interest and practical value. 3300 w. Ins Engng—May, 1903. No. 55304 C.

Intake Tunnel.

Defective Work in the Cleveland Water-Works Intake Tunnel. Describes the condition of the tunnel under Lake Erie, recently built. Ill. 1000 w. Eng Rec—May 23, 1903. No. 55357.

Medical Building.

Structural Details of the Medical Building, Cornell University. Illustrated description. 1800 w. Eng Rec—May 16, 1903. No. 55231.

Piers.

Personal Experiences in the Construction of a Landing Pier for the Ocos Railway, Guatamala, C. A. Charles List. An illustrated account of the history and construction of the pier, some of the experiences and deductions. 3000 w. Jour Assn of Engng Soc's—March, 1903. No. 55159 C.

Portable Structures.

Dismountable and Portable Structures (Un Système de Constructions Démontables). J. J. Pillet. An illustrated description of a system of construction for portable and semi-portable buildings of many kinds, for military and civil use, invented by Lieut. Col. Espitallier. 2000 w. Bull Soc d'Encour—April 30, 1903. No. 55400 G.

Reservoirs.

Estimating Soil Stripping from Water-Supply Reservoirs. Two papers and discussion at meeting of the Boston Soc. of Civ. Engrs. I. A Comparison of Three Methods of Estimating Quantities of Soil Stripping from Water-Supply Reservoirs. Frank S. Hart. II. Method of Estimating Quantities of Soil Excavation from Wachusett Reservoir. Charles A. Bowman. Ill. 14000 w. Journ Assn of Engng Soc's—April, 1903. No. 55292 C.

Roads.

Tar-Macadam Roadways in Ontario. Report of the city engineer of Hamilton, Ontario, describing the method of construction. Ill. 2500 w. U S Cons Repts, No. 1649—May 18, 1903. No. 55-256 D.

Coal Tar as a Road Material. Favors its use, discussing precautions necessary and giving general information. Ill. 1700 w. Automobile—May 23, 1903. No. 55338.

Improved Maintenance of Earth Roads. Henry P. Morrison. Suggests lines of investigation tending to the betterment of country roads. 1500 w. Eng Rec—May 2, 1903. No. 55116.

Underpinning.

Difficult Supports for Underpinning. Brief description, with illustrations, of difficult underpinning made necessary by quicksand, when adjacent foundations were excavated. 1200 w. Eng Rec—May 2, 1903. No. 55115.

MATERIALS.

Asphalt.

Rock Asphalt and Asphalt Mastic. Henry Wiederhold. Gives brief review of the uses of asphalt, where found, and the quality, especially considering rock asphalt and its value as a building material. General discussion. 9200 w. Pro Engrs Club of Phila—April, 1903. No. 55163 D.

Cement.

Manufacture of Cement from Marl and Clay. Henry S. Spackman. Information concerning the marl deposits and an illustrated account of the methods used. 4800 w. Pro Engrs Club of Phila—April, 1903. No. 55161 D.

Decay of Metals.

See Mechanical Engineering, Materials.

Forestry.

The Forest Policy of Pennsylvania. George H. Wirt. Reviews the policy of this State in the past, and discusses what it should be in the future. 5600 w. Jour Fr Inst—May, 1903. No. 55156 D.

Granite.

The Granite Industry of Maine. An illustrated article giving the location of some of the extensive deposits and information concerning the quality of the stone. 2000 w. Stone—April, 1903. No. 55183 C.

Slag Bricks.

The Manufacture of Slag Bricks and Slag Blocks. Edwin C. Eckel. Describes these products in detail. 3300 w. Eng News—April 30, 1903. No. 55087.

Slag Cement.

Portland Cement Manufactured from Blast-Furnace Slag. Chevalier C. de Schwarz. A paper before the Iron and

Steel Institute, giving a statement of the advantages and disadvantages of this product, for what uses adapted, etc., giving results of recent tests, and other information. 3500 w. Ir & Coal Trds Rev—May 8, 1903. No. 55330 A.

Timber.

I. The Use of Timber by Railroads and Its Relation to Forestry. Dr. Hermann von Schrenk. II. Railroad Interests in Forest Supplies. Prof. B. E. Fernow. Two papers on timber supply and preservation; followed by general discussion. Ill. 18000 w. N Y R R Club—April 17, 1903. No. 55291.

Wood Preservation.

Apparatus for and Methods of Treating Wood, to Protect It from Fire and Preserve It from Decay. Joseph L. Ferrell. Reviews the processes used for the protection from the attacks of flame and fungus. General discussion. 10500 w. Pro Engrs Club of Phila—April, 1903. No. 55164 D.

MEASUREMENT.

Arc of Meridian.

Report of the Commission for Geodetic Work at the Equator (Rapport Présenté au Nom de la Commission chargée du Contrôle Scientifique des Operations Géodésiques de l'Equateur). H. Poincaré. An account of progress made in measuring an arc of the meridian near Quito, Ecuador. 2800 w. Comptes Rendus—April 6, 1903. No. 54873 D.

Beams.

The Deflection of Beams when Unsymmetrically Loaded. P. P. Bredsten. Gives a time-saving diagram with brief explanation of its use. 200 w. Am Mach—April 30, 1903. No. 54985.

Bending Moments.

Curves of Maximum Bending Moment. Arthur L. Bell. Describes method of plotting the actual curves of maximum bending moment. 2400 w. Engr, Lond—May 8, 1903. No. 55285 A.

Cable Tension.

The Arnodin System of Measuring Cable Tension (Note sur les Cables Témoins, Système F. Arnodin). F. Arnodin. An illustrated description of a system of measuring the tension of cables and ropes by means of an auxiliary cable which is made to have the same curvature and which is connected to a dynamometer. 2500 w. Mem Soc Ing Civils de France—March, 1903. No. 55406 G.

Curves.

Special Methods of Determining Groups of Curves Representing Engineering Formulæ. W. F. Durand. Describes methods the use of which, where applicable, will effect a great saving of labor. 3000 w. Sib Jour of Engng—May, 1903. No. 55190 C.

Graphic Statics.

On the Use of Influence Lines in Graphic Statics. Myron S. Falk. Shows its use to indicate the position of the moving load causing the maximum shears, moments, reactions, or stresses in a truss. 3800 w. Sch of Mines Quar—Jan., 1903. No. 55154 D.

Riveted Joints.

The Polar Moment of Inertia, and Its Graphical Application to Riveted Joints. C. F. Blake and R. W. Runge. Mathematical discussion. 2500 w. Eng News—May 21, 1903. No. 55322.

MUNICIPAL.

Accounting.

Municipal Accounting. A discussion at the meeting of the National Conference for Good City Government, and the National Municipal League, concerning the need of uniformity, that statistics may be made of greater value. 2800 w. Eng Rec—May 2, 1903. No. 55118.

Asphalt.

Asphalt Experiments at Washington. Abstract of the report made by A. W. Dow, concerning investigations on asphalt for paving purposes. 1500 w. Eng Rec—May 2, 1903. No. 55117.

Drainage.

Power and Pumping Stations of the New Orleans Drainage System. W. M. Venable. Gives the general outlines of the drainage problems presented by the district and the plan adopted, and describes specifically the installations and operation of the pumping stations completed and the central station from which all are furnished with electric power. Illustrated. 4800 w. The Engineering Magazine—June, 1903. No. 55495 B.

Garbage.

An Investigation of a Garbage Crematory. Extracts from a report by Rudolph Hering to the Special Committee on Crematory of the City Council of Trenton, N. J. Descriptive. 3500 w. Sci Am Sup—May 16, 1903. Serial. 1st part. No. 55248.

Pavements.

How to Lay Brick Pavements. A digest of the model specifications used in Rochester, N. Y., where many miles of brick pavements are in good condition after hard service. 3500 w. Munic Jour & Engr—May, 1903. No. 55039 C.

See also Street and Electric Railways.

Sewerage.

Swampscott Sewerage System. Describes a system for this town on Massachusetts Bay. All the sewage is collected in a receiving basin and pumped through an 18-in. cast-iron pipe 2,200 feet to the shore, and from there directly out to sea, 3,600 ft. further. Ill. 1400 w. Eng Rec —May 23, 1903. No. 55356.

WATER SUPPLY.

Atlantic City.

Atlantic City Water-Works. An illustrated description of the system. The sources of supply are artesian wells, and Absecon creek. 1800 w. Fire & Water —May 23, 1903. No. 55336.

Brussels.

The Water Supply of Brussels in 1902 (Les Eaux de Bruxelles en 1902). E. d'Esmenard. An abstract of a report by E. Putzeys, chief engineer, on the water supply and service of Brussels. 2000 w. Rev Technique—April 10, 1903. No. 55420 D.

California.

Rainfall on the Pacific Coast of North and South America and the Factors of Water Supply in California. Marsden Manson. Shows the variations in the rainfall, considering how this, with other factors, controls the water supply, the storage facilities, and related subjects. Map. 5000 w. Jour Assn of Engng Soc's—March, 1903. No. 55158 C.

Ground Water.

The Rapidity of Flow of Ground Water (Sur la Vitesse d'Ecoulement des Eaux Souterraines). E. Fournier and A. Magnin. An account of experiments on the flow of subterranean waters, with particular reference to their use for drinking. 500 w. Comptes Rendus—April 6, 1903. No. 54874 D.

Laboratories.

Biological and Chemical Laboratories of the Water Department of New York City. George C. Whipple. A review of the work carried on at these laboratories, the supervision, tests, analyses, and sanitary investigations. 2500 w. Eng Rec—May 9, 1903. No. 55147.

Philadelphia.

The Center Square Water-Works of Philadelphia; the Source of Water Supply from 1801 to 1815. A brief sketch of the early history of the Philadelphia supply, with illustrated description of the first pumping station, and the wooden boilers used. 1700 w. Engs News—May 14, 1903. No. 55216.

Reservoirs.

The Utilization of Utah Lake as a Reservoir. W. P. Hardesty. Describes this lake, which is about 30 miles from Salt Lake City, showing that it is almost a natural reservoir. Gives an account of efforts to utilize more of the water by pumping, and discusses its possibilities as a reservoir. Ill. 5800 w. Eng News—May 21, 1903. No. 55318.

See also Civil Engineering, Construction.

ELECTRICAL ENGINEERING

COMMUNICATION.

Automatic Telephone.

Automatic Telephone Systems. A. Dallam O'Brien. The present article gives an illustrated description of the Ness interior system. 1600 w. Am Elect'n—May, 1903. No. 55112.

Cable Testing.

Some Notes on Cable Testing. W. Dalton. The first of a series of articles giving practical points on cable testing, illustrated by examples. 2500 w. Elec Engr, Lond—April 24, 1903. Serial. 1st part. No. 55008 A.

Printing Telephone.

A Sketch for a Type-Printing Telephonograph (Skizze zu einem Typen-Druck-Telephonographen). W. Krejza. A suggestion, with diagram, for a system using selective receiving telephones, each of which would respond to the sound corresponding to a letter and would operate a relay which would actuate the type-printing mechanism. 500 w. Zeitschr f Elektrotechnik—April 12, 1903. No. 55473 D.

Space Telegraphy.

Hertzian Wave Wireless Telegraphy. Dr. J. A. Fleming. The first of a series of articles giving an account of the present condition of electric-wave telegraphy. The discussion is limited to an account of the scientific principles underlying the operation of this particular form of wireless telegraphy. 10700 w. Ill. Pop Sci M—June. Serial. 1st part. No. 55-394 C.

De Forest Wireless Telegraph System. A. Frederick Collins. An illustrated description of this system, and particularly of the receiving apparatus which employs an electrolytic responder, whose resistance increases upon the impact of the electric waves. 1600 w. Elec Wld & Engr—April 11, 1903. No. 54996.

Branly-Popp Aerial Telegraphy System. Brief illustrated description of this system and an account of the schemes in Paris to operate it. 1500 w. Elec Wld & Engr—May 16, 1903. No. 55225.

Some Problems in Space Telegraphy. Joseph B. Baker. Discusses principally the subject of tuning, and the progress made. 2000 w. Elec Rev, N. Y.—May 16, 1903. No. 55222.

Space Telephony.

Wireless Telephonic Communication Between Moving Ferry Boats. Dr. T. Byard Collins. An illustrated account of the experiments made by A. Frederick Collins in New York Harbor. 1100 w. Sci Am—May 23, 1903. No. 55315.

Telephone Exchange.

The New Brussels Telephone Exchange. An illustrated description of an exchange designed in accordance with the recommendations of a commission appointed to investigate modern systems. 1500 w. Elec Wld & Engr—May 2, 1903. No. 55076.

Telephone Service.

Telephone Service. S. J. Larned. A discussion of its value, and of the organization and methods of good service. 6000 w. Jour W Soc of Engrs—April, 1903. No. 54993 D.

Telephone Switchboards.

Divided Multiple Switchboards: An Efficient Telephone System for the World's Capitals. W. Aitken. Abstract. Considers methods used, and the common battery system, and describes the system suggested. 2500 w. Elec Rev, Lond—May 15, 1903. Serial. 1st part. No. 55366 A.

Telephone Wires.

The Tension of Telephone Wires. Pierre Vandeuren. Calculations relating to steel lattice work poles, carrying large numbers of wires. 12200 w. 1 table and figure. Bul International Ry Cong—April, 1903. No. 55381 E.

DISTRIBUTION.

Alternating Current.

Grounding of Alternate Current Systems. George N. Eastman. Presents a few problems with diagrams showing conditions which may arise and produce very disastrous results. 2500 w. Jour W Soc of Engrs—April, 1903. No. 54995 D.

Capacity.

Capacity Relations in Cables (Kapacitätsverhältnisse in Kabeln). Dr. H. Andriessen. A theoretical discussion of the electrostatic capacity of cables, taking the most general case. 1600 w. Elektrotech Zeitschr—April 30, 1903. No. 55456 B.

Network Calculations.

A Simple Method for the Calculation of Closed Conducting Networks (Eine Einfache Methode zur Berechnung von Geschlossenen Leitungsnetzen). Dr. H. Gallusser. A graphical and mathematic method for calculating the current distribution in networks. Diagrams. 2000 w. Elektrotech Zeitschr—April 23, 1903. No. 55455 B.

Safety Devices.

Safety Devices for High-Tension Alternating-Current Lines (Sicherungen für Wechselstrom — Hochspannungsleitungen). Franz Probst. An illustrated description of safety devices to protect electric lines and apparatus against excessive currents and excessive pressures, including fuses, lightning arresters, etc. Serial. 2 Parts. 5000 w. Zeitschr f Elektrotechnik—March 29 and April 5, 1903. No. 55469 each D.

Standards.

Standards for Conductors (Normalien für Leitungen). Standards for electric conductors and cables for all kinds of purposes, proposed by a Committee of the Verband Deutscher Elektrotechniker. 2000 w. Elektrotech Zeitschr—May 7, 1903. No. 55462 B.

Sub-Stations.

The Development, Equipment, and Operation of the Sub-Stations and Distributing Systems of the Chicago Edison Co. and Commonwealth Electric Co. Ernest F. Smith. General description of methods and details. 4800 w. Jour W Soc of Engrs—April, 1903. No. 54994 D.

Switches.

See Electrical Engineering, Generating Stations.

ELECTRO-CHEMISTRY.

Accumulator.

The Tribelhorn Accumulator (Les Accumulateurs Tribelhorn). L. Brossement. An illustrated description of an accumulator in which the active material is placed on opposite sides of saucer-shaped elements, which are then piled on top of each other, and separated by glass balls, to form a battery. 600 w. Rev Technique—April 10, 1903. No. 55419 D.

Address.

Electro-Chemistry (Ueber Elektrochemie). Viktor Engelhardt. An address, giving a general review. 2000 w. Zeitschr d Oesterr Ing u Arch Ver (Supplement)—March 20, 1903. No. 55478 B.

Bipolar Electrodes.

Bipolar Electrodes (Ueber Bipolare Elektroden). André Brochet and C. L. Barillet. An account of experiments in the Laboratorie d'Electrochimie, Ecole de Physique et de Chimie Industrielles de Paris, with bipolar electrodes, or metal partitions in electrolytic cells which act as both anodes and cathodes. 2600 w. Zeitschr f Elektrochemie—March 26, 1903. No. 55485 G.

Bipolar Electrodes and Metal Diaphragms (Ueber Zweipolige Elektroden und Metalldiaphragmen). H. Danneel. An account of experiments, at the Institut für Metallhüttenwesen und Elektrometallurgie, in Aachen, with bipolar electrodes, or metal partitions in electrolytic cells which act as both anode and cathode; also discussion of experiments of Messrs. Brochet and Barillet. 2500 w. Zeitschr f Elektrochemie—March 26, 1903. No. 55486 G.

Dissociation Theory.

Some Applications of the Electrolytic Dissociation Theory to Medicine and Biology. Wilder D. Bancroft. Lecture before the Am. Phil. Soc. A critical summary of the achievements in medicine and biology, due to applications of the dissociation theory. 3000 w. Elec-Chem Ind —May, 1903. No. 55239 C.

Electric Furnace.

The Application of the Electrical Furnace in Metallurgy. Albert Keller. A paper before the Iron and Steel Institute, which considers this subject, the figures given being based on experiments carried out on an industrial scale at various electric works driven by water power. 7000 w. Ir & Coal Trds Rev—May 8, 1903. No. 55329 A.

Electroplating.

The Electrodeposition of Metals on Rotating Cathodes. Abstract of paper by J. G. Zimmerman, read before the Am. Elec.-Chem. Soc. Showing that in electroplating smooth deposits can be obtained with comparatively high current densities, if the cathode is revolved. 900 w. Elec-Chem Ind—May, 1903. No. 55241 C.

Metallic Compounds.

Electrolytic Production of Metallic Compounds. Prof. C. F. Burgess and Carl Hambruchen. Abstract of paper read before the Am. Elec.-Chem. Soc. An account of experimental study of various processes, especially for the production of white lead. 3700 w. Elec-Chem Ind—May, 1903. No. 55240 C.

Platinum.

The Electrolytic Dissolving of Platinum by Means of Alternating Currents (Ueber die Elektrolytische Auflösung von Platin Mittels Wechselströmen). Rudof Ruer. An account of experiments on the solubility of platinum in different electrolytes under the influence of alternating electric currents, and theoretical discussion. 2500 w. Zeitschr f Elektrochemie—March 19, 1903. No. 55484 G.

Zinc Extraction.

See Mining and Metallurgy, Miscellany.

ELECTRO-PHYSICS.

Arc Converters.

Pulsating Direct Currents in Alternating Current Electric Arcs (Pulsierende Gleichströme im Wechselstromlichtbogen). Berthold Monasch. Address before the Elektrotech. Verein of the Darmstadt Technical School, in which, apropos of the Cooper-Hewitt converter, a review is given of former methods of deriving pulsating direct currents from alternating current arcs. 2500 w. Elektrotech Zeitschr —April 30, 1903. No. 55457 B.

Coherers.

Coherer Action Under the Microscope. G. T. Hanchett. Gives an experimental microscopic investigation, deducing the requirements for a good coherer. 700 w. Elec Rev, N. Y.—May 2, 1903. No. 55085.

Electric Convection.

On Electric Convection (Sur la Convection Electrique). M. Vasilesco-Karpen. An account of experiments to show that a moving electrified body produces a magnetic field, as first proved by Rowland. 700 w. Comptes Rendus—March 9, 1903. No. 54865 D.

Researches in Electric Convection (Recherches sur la Convection Electrique). V. Crémieu and H. Pender. An account of experiments to determine the influence of a moving electrified body on a magnet. 600 w. Comptes Rendus—April 20, 1903. No. 54877 D.

Electrons.

Ions and Electrons. Abstract of a paper by Dr. Louis A. Parsons, read before the Am. Elec.-Chem. Soc. A review of investigations which led to the modern electronic hypothesis. 1200 w. Elec-Chem Ind —May, 1903. No. 55242 C.

Hysteresis.

Magnetic Hysteresis at High Frequencies (Sur l'Hystérésis Magnétique aux Fréquences Elevées). C. E. Guye and B. Herzfeld. An account of experiments with frequencies up to 1.200 per second, tending to show that the hysteresis energy loss per cycle is independent of the frequency. 700 w. Comptes Rendus—April 20, 1903. No. 54878 D.

Magnetization Curve.

Calculation of the Magnetization Curve (Rechnerische Ermittelung der Magnetisierungskurve). Iwan Döry. Formulæ and methods of calculating the magnetization curve of iron which give results agreeing very well with those observed. 1000 w. Zeitschr f Elektrotechnik—March 29, 1903. No. 55470 D.

Radio-Activity.

Radium. Prof. J. J. Thomson. The radio-activity of radium is explained by the hypothesis that some of the atoms of radium are in an unstable condition and that in passing into other configurations they give out a large amount of energy. 1400 w. Nature—April 30, 1903. No. 54863 A.

The Radiation from Polonium and the Secondary Radiation which it Produces (Sur le Rayonnement du Polonium et sur le Rayonnement Secondaire qu'il Produit). Henri Becquerel. An account of experiments with radioactive substances. 1200 w. Comptes Rendus—April 27, 1903. No. 54880 D.

A New Kind of Light (Sur une Nouvelle Espèce de Lumière). R. Blondlot. An account of experiments with rays from a tube, which can be reflected, refracted and polarized. 700 w. Comptes Rendus —March 23, 1903. No. 54871 D.

Radium, Radioactivity and Hypotheses (Le Radium—la Radioactivité — Hypothèses). Paul Besson. A review of radioactive phenomena, and hypotheses of the constitution of matter and the propagation of light. 4000 w. Mem Soc Ing Civils de France—March, 1903. No. 55410 G.

On the "Emanation Substance" from Pitchblende, and on Radium. F. Giesel. An account of researches. 2000 w. Sci Am Sup—May 16, 1903. No. 55246.

Radium and Its Position in Nature. William Ackroyd. Gives a brief account of the discovery of this element, its rarity, properties, etc., discussing its scientific value. 4500 w. Nineteenth Cent—May, 1903. No. 55259 D.

Some Recent Advances in Radioactivity. Frederick Soddy. An account of the researches of Professor Rutherford and his co-workers at McGill University. 6000 w. Contemporary Rev—May, 1903. No. 55-215 D.

Stereoscopic Radioscopy (Procédé de Radioscopie Stéréoscopique). Th. Guilloz. Description of an arrangement of Roentgen-ray apparatus which gives good stereoscopic vision in examinations of the human body. 600 w. Comptes Rendus—March 9, 1903. No. 54866 D.

A Stereoscope for Röntgen Ray Photographs. Describes an ingenious direct-vision stereoscope, devised by Dr. Walter, of Hamburg, capable of viewing photographs of any size. Ill. 1400 w. Elec Rev, Lond—April 24, 1903. No. 55009 A.

Spark Phenomena.

The Projection of Matter About an Electric Spark (Sur la Projection de la Matière autour de l'Etincelle Electrique). Jules Semenov. An account of experiments with electric discharges through flames, showing that the transport of matter from one electrode to another is only a secondary phenomenon. 600 w. Comptes Rendus—April 14, 1903. No. 54875 D.

Thermo-Electricity.

Thermo-Electromotive Force Without Difference of Temperature. Abstract of a paper by Prof. Henry S. Carhart, read before the Am. Elec.-Chem. Soc. On the thermodynamical theory of galvanic cells. 2300 w. Elec Chem Ind—May, 1903. No. 55243 C.

GENERATING STATIONS.

Aberdeen.

The New Aberdeen Electricity Works. Illustrated detailed description of a new generating station in Scotland. 3500 w. Elec Rev, Lond—May 1, 1903. No. 55-195 A.

Bank, Pittsburg.

Electrical Equipment of the Farmers' Bank Building, Pittsburg. L. L. Emerson. Describes an alternating-current system of electric service; an extensive power plant has been installed and the entire building wired for illumination by the Nernst lamp. Ill. 1600 w. Eng Rec—May 9, 1903. No. 55148.

Chicago.

Recent Development of the Chicago Edison and Commonwealth Electric Systems. An account of the remarkable progress in this field, describing the great Fiske Street station, now under construction, designed for the use of 5,000-kw. Curtis steam turbine units and other interesting apparatus to be installed. Also describes briefly other stations of interest. Ill. 4800 w. Elec Wld & Engr—May 23, 1903. No. 55515.

Compounding.

The Compounding of Self-Excited Alternating Current Generators for Variation in Load and Power Factor. A. S. Garfield. A description of the characteristics of a polyphase alternating current revolving field generator provided with a single closed-circuit field-winding and commutator. Ill. 1800 w. Am Inst of Elec Engrs —May 19, 1903. No. 52294 D.

Consolidations.

Centralized Management of Electrical Properties. H. S. Knowlton. Showing the gains which may sometimes be attained by consolidation and centralized management. 1600 w. Elec Wld & Engr —May 23, 1903. No. 55518.

De Kalb, Ill.

A Very Modern Central Station of Medium Size. J. R. Cravath. An illustrated description of the central station at De Kalb, Ill., and its equipment. 2200 w. Am Elect'n—June, 1903. No. 55526.

Dynamo Troubles.

Failure of Direct Current Dynamos to Generate. E. C. Parham. Considers some of the causes of disorder leading to a failure of the dynamo to do its duty. 1500 w. Am Elect'n—May, 1903. No. 55113.

Electro-Plating.

Design for a 150-Ampere Electro-Plating Dynamo. Cecil P. Poole. Reproductions of working drawings with descriptive notes. 1800 w. Am Elect'n—June, 1903. No. 55529.

Everett, Wash.

Design of the New Power Plant and System of the Everett Railway & Electric Co. Edward P. Burch. From a recent address before the students in power plant design at Minnesota State Univ. Illustrates and describes this plant for a city in Washington. 3000 w. St Ry Rev—May 20, 1903. No. 55307 C.

Field Coils.

Field Coil Formulas. Thorburn Reid. Gives approximate equations deduced by the writer and used constantly in calculating the weight of copper, depth of coil, number of turns, size of wire, etc., in field coils. 1800 w. Elec Wld & Engr—May 16, 1903. No. 55226.

Government Printing Office.

Power Plant of the Government Printing Office at Washington. An illustrated detailed description of the enlarged plant which is to serve the new office and the old adjacent plant. The present article describes the boiler plant. 2300 w. Eng Rec—May 16, 1903. Serial. 1st part. No. 55230.

Hydro-Electric.

Design of Electric Water Power Stations. Alton D. Adams. Describes types of water-power stations in detail, with methods of driving, and features of interest. Ill. 4000 w. Elec Rev, N. Y.—May 23, 1903. No. 55511.

Water Power in Electrical Supply. Alton D. Adams. Reviews the development of electric water power systems in America, giving information of interest. 2500 w. Elec Rev, N. Y.—May 9, 1903. No. 55133.

Maintenance and Operation of Central Stations by Water-Power. George S. Carson. Read before the Iowa Elec. Assn. Reports concerning an installation on the Iowa river and briefly discusses the subject generally. 2000 w. Engr, U S A—May 15, 1903. No. 55237 C.

Small Water Powers with High Heads for Electric Lighting. Thorburne Reid. Suggestions for the utilization of such streams, describing a plant in detail. 2500 w. Cassier's Mag—May, 1903. No. 55178 B.

See also Civil Engineering, Canals, Rivers and Harbors.

Italy.

Great Electric Installations of Italy. The Hydro-Electric Station of Cenischia. Enrico Bignami. Illustrated description of the hydraulic and electric features of a characteristic Alpine station designed to use 1,400 litres per second under a head of 859 metres. Illustrated. 3000 w. The Engineering Magazine—June, 1903. No. 55496 B.

Kansas City.

The Central Avenue Power Station. H. S. Badger and G. E. Schreiber. An illustrated detailed description of a recent installation in Kansas City, Kan. 6500 w. Power—May, 1903. No. 55067 C.

Load Diagrams.

See Street and Electric Railways.

Massachusetts.

Statistics of the Massachusetts Electrical Supply System in 1902. Alton D. Adams. 2500 w. Elec Wld & Engr—May 23, 1902. No. 55517.

Municipal Plants.

Investments and Earnings of Municipal Electric Plants. Alton D. Adams. Aims to determine the ratio of net earnings to investments in plants built by towns in Massachusetts, comparing the results with the ratio in similar plants owned by private corporations. 1800 w. Munic & Engng—May, 1903. No. 55184 C.

Municipal Electricity Undertakings. Claims that municipal balance sheets are not kept in a way that shows the actual state of affairs. Gives example, analyzing balance sheets. 1400 w. Elec Rev, Lond—May 15, 1903. No. 55368 A.

N. Y. Stock Exchange.

The New Headquarters of the Stock Exchange, New York City. An illustrated description of the power plant, annunciator service, and telephone system. 3800 w. Elec Rev, N. Y.—May 9, 1903. No. 55134.

Pontiac, Ill.

The Pontiac Light and Water Co., Pontiac, Ill. An illustrated account of a company uniting most of the public utilities under one management, for a town of about 6,500 inhabitants. 3200 w. Elec Wld & Engr—May 23, 1903. No. 55516.

Records.

Notes on the Design of Central-Station Records and Returns. F. H. Davis. Notes describing the practice in several well-managed stations. 6000 w. Elec Engr, Lond—May 8, 1903. No. 55273 A.

Regulation.

The Experimental Basis for the Theory of the Regulation of Alternators. B. A. Behrend. Aims to supply data to enable the Committee on Standardization to draw up rules for the determination of voltage regulation. 4700 w. Am Inst of Elec Engrs—May 19, 1903. No. 55295 D.

Spezia Arsenal.

The Electric Plant of the Royal Arsenal at Spezia, Italy (L'Impianto Elettrico del

R. Arsenale di Spezia). Attilio Incontri. An illustrated description of an alternating and direct-current plant for light and power at this naval station. 12 plates. 6000 w. Rivista Marittima—Feb., 1903. No. 55489 H.

Sugar Refinery.

See Mechanical Engineering, Miscellany.

Switches.

The Design of Switching Apparatus for High Tension Central Stations (Ueber den Entwurf von Schaltanlagen für Hochspannungszentralen). Dr. Benischke. A paper giving an illustrated description of modern high-tension switching apparatus. 3000 w. Zeitschr f Elektrotechnik—March 15, 1903. No. 55467 D.

Teplitz-Schonau.

The Municipal Electrical Works at Teplitz-Schönau, Bohemia (Das Städtische Elektrizitätswerk in Teplitz-Schönau). A Frühwirth. An illustrated description of the station and distributing three-wire system, their cost and the charges for current. 3500 w. Zeitschr d Oesterr Ing u Arch Ver—March 13, 1903. No. 55475 B.

Wiesberg.

The Wiesberg Electric Station (Das Elektricitätswerk Wiesberg). W. Stoeger. An illustrated description of a hydro-electric station in the Tyrol, for supplying the district about Landeck with current for electrochemical and other purposes. 1600 w. Elektrotech Zeitschr—May 14, 1903. No. 55464 B.

LIGHTING.

Illumination.

The Engineering of Illumination. Van Rensselaer Lansingh. Considers the factors consituting good illumination, and the principles of interior illumination, especially in buildings for public use. Ill. 7800 w. Jour W Soc of Engrs—April, 1903. No. 54990 D.

Isolated Plants.

The Economy of Isolated Electric Light Equipments in Small Factories. F. O. Runyon. A short article showing the cost of installing and maintaining such plants. 1200 w. Elec Rev, N. Y.—May 16, 1903. No. 55223.

Lamp Manufacture.

The Manufacture of Incandescent Lamps. Describes the making of incandescent electric lamps as carried on at the works of the Sir Hiram Maxim Electrical and Engineering Company. Ill. 5700 w. Engng—May 8, 1903. No. 55281 A.

MEASUREMENT.

Differential Telephone.

The Use of Differentially Wound Telephone Receiver in Electrical Measurements. Prof. H. Ho. Calls attention to the uses which can be made of the differential telephone for the purposes of measurement. 700 w. Elec Wld & Engr—May 23, 1903. No. 55519.

Galvanometer.

A Recording Galvanometer and a Revolving Contact and their Employment in Tracing Alternating-Current Curves (Sur un Galvanomètre Enregistreur et un Contact Tournant, et sur leur Emploi au Tracé des Courbes de Courants Alternatifs). J. Carpentier. A description of two pieces of apparatus, which may be used independently or together. 700 w. Comptes Rendus—April 20, 1903. No. 54879 D.

Iron Tests.

Apparatus for Making Magnetic Tests of Entire Sheets of Iron (Eisenprüfapparat für Ganze Blechtafeln). Rudolf Richter. An illustrated description of a large cylindrical apparatus used by Siemens & Halske for making electromagnetic tests of whole sheets of iron for electric apparatus. 1800 w. Elektrotech Zeitschr—May 7, 1903. No. 55458 B.

Magnetometer.

An Apparatus for Exploring Feeble Magnetic Fields (Nouveaux Systèmes Magnétiques pour l'Etude des Champs Très Faibles). V. Cremieu and H. Pender. A description of a magnetometer consisting of a small horizontal arm suspended by a fine wire, with a vertical magnet at one end and a counterweight at the other. This arrangement may be applied also in a sensitive galvanometer. 600 w. Comptes Rendus—March 9, 1903. No. 54864 D.

Oscillograph.

Blondel Oscillograph. Henry Hale. Illustrated description of the latest form of this apparatus which gives a visual representation of alternating-current waves. 1400 w. Elec Wld & Engr—May 2, 1903. No. 55077.

Potentiometer.

The Crompton Potentiometer for Electrical Measurements with Direct Current Supply. Illustrates and describes this instrument which is in use in many electric lighting and power stations in England. 1500 w. Sci Am Sup—May 16, 1903. No. 55249.

Thermostat.

An Electric Thermostat (Sur un Thermostat à Chauffage et Régulation Electriques). C. Marie and R. Marquis. An illustrated description of a bath for physical experiments which is heated by an electric current and whose temperature is regulated very closely by an electric thermostat. 200 w. Comptes Rendus—March 9, 1903. No. 54867 D.

Watt-Hour Meters.

Report of the Reichsanstalt on Aron Meters (Mitteilungen der Physikalisch-Technischen Reichsanstalt. Bekanntmachung über Prüfungen und Beglaubigungen durch die Elektrischen Prüfämter). A report and certification from the electrical testing bureau of the Reichsanstalt, Charlottenburg, Germany, giving an illustrated description of Aron watt-hour meters for direct and for alternating current. 1600 w. Elektrotech Zeitschr—May 14, 1903. No. 55463 B.

POWER APPLICATIONS.

Coal Mining.

Electrical Apparatus for Coal-Mining. W. B. Clarke. Discusses recent developments in connection with electrical apparatus for the mining of coal. 4000 w. Trans Am Inst of Min Engrs—Feb., 1903. No. 55385.

Electrical Apparatus for Coal-Mining. W. L. Saunders. Remarks made in discussing the paper on this subject by W. B. Clarke, at the Albany meeting of the Am. Inst. of Min. Engrs. 5000 w. Compressed Air—May, 1903. No. 55520.

Control.

Shunt-Field and Variable Voltage Control for Electric Motors. William Cooper. Extracts from a paper read before the Cincinnati Chapter of the Am. Inst. of Elec. Engrs. Gives a useful diagram and explains a system of determining the minimum size motor. 3400 w. Am Mach—April 30, 1903. No. 54986.

Drills.

Electric Mining Drills Abroad. Frank C. Perkins. Illustrated description of Siemens & Halske and other drills as used in German mines. 3000 w. Mines & Min—May, 1903. No. 55055 C.

Elevators.

Induction Motors for Elevators. A. B. Weeks. An illustrated description of some of the apparatus employed and notes on the care of it. 1500 w. Am Elect'n—June, 1903. No. 55530.

Glass Works.

Induction Motors in a Plate Glass Factory. J. R. Cravath. Brief illustrated description of the plant of the Edward Ford Plate Glass Co., near Toledo, Ohio. 800 w. Am Elect'n—May, 1903. No. 55109.

Heyland Motor.

A Study of the Heyland Machine as a Motor and Generator. Comfort A. Adams. A report of experimental work, with a review of the history and general theory. Ill. 13000 w. Am Inst of Elec Engrs—May 19, 1903. No. 55296 D.

The Heyland Single-Phase Motor (Der Einphasenmotor System Heyland in Seiner Heutigen Ausführung und Verwendung). André Schmidt. An illustrated description of this single-phase alternating-current motor which can start under load, and its present applications. 2500 w. Elektrotech Zeitschr—May 7, 1903. No. 55460 B.

Induction Motors.

The Induction Motor. George T. Hanchett. Describes the electrical and mechanical characteristics, explaining the general principle of the machine. Ill. 3000 w. Cent Sta—May, 1903. No. 55258.

Lathe.

See Mechanical Engineering, Machine Works and Foundries.

Locks.

See Civil Engineering, Canals, Rivers and Harbors.

Machine Shop.

The Development and Use of the Small Electric Motor. III. The Choice of Motors for Machine Shop and Factory. Fred. M. Kimball. This third paper in the current series describes the types of motors and discusses their choice, installation, and daily operation from the standpoint of the power user. It gives some valuable data of power required for various machines and of running costs. Illustrated. 5000 w. The Engineering Magazine—June, 1903. No. 55497 B.

Electric Driving in Machine Shops, Engineering and Shipbuilding Works. Reviews the papers by A. B. Chatwood and by A. D. Williamson, dealing with this subject. 1700 w. Elec Rev, Lond—May 15, 1903. Serial. 1st part. No. 55365 A.

The Wüst System of Driving Machine Tools and Hoisting Machinery. Illustrates and describes the Wüst patent multi-speed polyphase motor and its working. 2000 w. Elec Rev, Lond—May 1, 1903. No. 55197 A.

Driving Planers. J. C. Steen. Remarks on the variable power required as revealed by the individual motor drive. 600 w. Am Engr & R R Jour—May, 1903. No. 55073 C.

Mining.

Electricity in Mines. Reports to the Departmental Committee on Electricity in Mines, including an account of valuable experiments to test the liability of continuous-current motors on coal-cutters to ignite gas, undertaken and reported by W. E. Garforth. Ill. 3300 w. Col Guard—May 1, 1903. No. 55203 A.

The Motive Power of the Future. Horace D. B. How. Abstract of a paper read before the South Wales Inst. of Engrs. An illustrated article considering the possibilities of electrical power at present and the future outlook. 3000 w. Ir & Coal Trds Rev—May 1, 1903. No. 55207 A.

Mining Pumps.

Alternating and Direct Current Mining Pumps. Frank C. Perkins. Describes successful types of electric pumping plants, giving information of interest. Ill. 2000 w. Min Rept—May 14, 1903. No. 55251.

Polyphase Motors.

The Theory and Operation of Polyphase Motors with Commutators and Shunt Excitation (Beitrag zur Theorie und Wirkungsweise der Mehrphasigen Kommutatormotoren mit Nebenschluss-erregung). O. S. Bragstad. An illustrated theoretical and descriptive discussion of these electric motors. Serial. Part 1. 1800 w. Elektrotech Zeitschr—May 14, 1903. No. 55465 B.

Polyphase Motor Installations. The first of a series of papers aiming to give in a brief and simple manner such information as will enable the engineer in charge, who has no special knowledge of electrical matters, to understand the plant put under his care. 4000 w. Prac Engr—April 24, 1903. Serial. 1st part. No. 55002 A.

The Winter-Eichberg System for Regulating the Speed of Polyphase Motors (Regulierbare Drehstrommotore. System Winter-Eichberg). G. Winter. An illustrated description of a polyphase motor in which the rotor has an auxiliary winding and a commutator, with brushes connected to a transformer which can be varied. 1500 w. Zeitschr f Elektrotechnik—April 12, 1903. No. 55471 D.

Shipyard.

Electric Installation of the Vulcan Shipyard. A. Richardson. Gives an illustrated detailed description of the re-equipment of this important shipbuilding establishment in Germany. 6500 w. Trac & Trans—May, 1903. Serial. 1st part. No. 55277 E.

TRANSMISSION.

Address.

Electric Transmission of Power (Ueber Elektrische Kraftübertragung). Friedrich Drexler. An address, giving general historical and descriptive review of electric power transmission. 2 plates. 4000 w. Zeitschr d Oesterr Ing u Arch Ver (Supplement)—March 20, 1903. No. 55477 B.

France.

The Distribution of Electrical Energy at 20,000 Volts in the Department of the Aude. Enrico Bignami. An illustrated detailed description of a system with 400 kilometres (250 miles) of lines. 3500 w. Elec Rev, N Y—May 23, 1903. No. 55513.

Greece.

Power Transmission in Greece. Illustrates and describes a recently completed plant for the utilization of water power and the transmission of energy—the plant of the Lake Copais Co., Ltd. 1200 w. Elec Rev, Lond—May 8, 1903. No. 55274 A.

Long Distance.

Some Difficulties of Long-Distance Electrical Transmission. P. M. Lincoln. Address delivered before the Cleveland Elec. Club. Considers some of the troubles that arise and means of avoiding some of them. General discussion. 4500 w. Engr, U S A—May 1, 1903. No. 55084 B.

The Continuous and Alternating Current. Alton D. Adams. Considers the relative advantages of each for power transmission as shown on long-distance lines in Switzerland. 3200 w. Mines & Min—May, 1903. No. 55058 C.

Polycyclic System.

The Arnold-Bragstadt-La Cour Polycyclic Power-Transmission. O. S. Bragstadt. An illustrated description of a composite system of transmission. 2500 w. Elec Wld & Engr—May 9, 1903. No. 55141.

MISCELLANY.

Coat of Mail.

Artemiev's Electrical Coat of Mail. Emile Guarini. An illustrated article describing this garment for affording protection against high electrical tensions. 600 w. Sci Am—May 16, 1903. No. 55244.

Electric Clock.

The David Perret Electric Clock. Emile Guarini. An illustrated description of a clock invented by a Swiss electrician. 1100 w. Sci Am Sup—May 30, 1903. No. 55525.

Europe.

Notes on Recent Electrical and Scientific Developments. William J. Hammer. An illustrated article describing details of the Valtellina 20,000-volt three-phase railway in Italy; three-phase Cruto, and Ganz lamps, Osmium and Nernst lamps. 4400 w. Jour Fr Inst—May, 1903. Serial. 1st part. No. 55155 D.

Irish Bogs.

See Industrial Economy.

Lightning Protection.

Report of a Committee of the Elektrotechnischer Verein on the Protection of Electric Plants Against Atmospheric Discharges (Bericht des Technischen Ausschusses des Elektrotechnischen Vereins über den Schutz Elektrischer Starkstromanlagen Gegen Atmosphärische Entladungen.) A report giving a synopsis of answers to questions sent to electric plants in Germany and Austria. 2000 w. Elektrotech Zeitschr—May 7, 1903. No. 55461 B.

Mechanical Applications.

The Mechanical Application of Electricity. W. B. Smith Whaley. Abstract of a lecture before Sibley College. Describing and illustrating the great progress made in the development of the application of electricity to the mechanic arts. 1800 w. Sib Jour of Engng—May, 1903. No. 55189 C.

Prospecting.

Electric Ore-Finding System. Edward Skewes. A discussion of the Daft and Williams electrical prospecting system. Thinks the system has possibilities, but at present its claims are "not proven." 3000 w. Eng & Min Jour—May 23, 1903. No. 55348.

Spain.

Electrical Progress in Spain. Henry L. Geissel. A report of the slow but steady progress being made in the electrical development. 1600 w. Elec Wld & Engr—May 2, 1903. No. 55078.

Stray Currents.

Regulations for the Protection of Metallic Pipes Against Stray Currents from Electric Railways (Leitsätze Betreffend den Schutz Metallischer Rohrleitungen Gegen Erdströme Elektrischer Bahnen). Regulations proposed by a Committee of the Verband Deutscher Elektrotechniker. 1500 w. Elektrotech Zeitschr—May 14, 1903. No. 55466 B.

GAS WORKS ENGINEERING

Alcohol Incandescent Lamps.

Incandescent Lighting with Alcohol (L'Alcohol Industriel-Eclairage par Incandescence). M. Luc. An illustrated description of various alcohol lamps with incandescent mantels. 2500 w. Rev Technique—March 25, 1903. No. 55416 D.

Benzene.

The Determination of Benzene in Illuminating Gas. L. M. Dennis and J. G. O'Neill, in *Jour. Am. Chem. Soc.* Describes a series of experiments, discussing the results. 3200 w. Am Gas Lgt Jour—May 18, 1903. No. 55255.

Calorimetry.

Calorimetry. E. Fearon. Read at meeting of the Manchester and Dist. Jr. Gas Assn., England. Describes method of determining the calorific value of gas by means of a calorimeter. 2200 w. Am Gas Lgt Jour—May 18, 1903. No. 55254.

Car Lighting.

Incandescent Gas Lighting for Railway Cars (Eclairage des Voitures de Chemins de Fer au Moyen de l'Incandescence par le Gaz). H. Giraud and G. Mauclère. An illustrated account of successful experience in lighting cars of the Eastern Ry. of France by incandescent gas light, using various kinds of gas. 5000 w. Rev Gén des Chem de Fer—May, 1903. No. 55404 H.

Firing.

Some Remarks on Gaseous Firing. Arthur Valon. Discusses some points in connection with a paper recently read by Mr. Whyte bearing on this subject. 1400 w. Jour Gas Lgt—May 19, 1903. No. 55-397 A.

Fuel Gas.

Recent Developments in the Use of Gas for Fuel. William H. Morse. An outline of the present status and future outlook of gas used for the development of power. 4000 w. Engr, U S A—May 15, 1903. No. 55236 C.

Gas-Burners.

The Law and Practice Relating to Test Gas Burners. States how the case of the standard test-burner stands in England, both in law and by usage. 3500 w. Jour Gas Lgt—May 19, 1903. No. 55396 A.

Gaseous Mixtures.

Heat Reactions of Gaseous Mixtures. Extracts from a paper by R. Forbes Carpenter and S. E. Linder, published in the *Journal of the Society of Chemical Industry.* Deals with the heat reactions, theoretically considered, of different gaseous mixtures. 2800 w. Jour Gas Lgt—May 12, 1903. No. 55310 A.

Heating.

Domestic Heating by Gas. Donald McDonald. Read before the Ohio Gas Lgt. Assn. Discusses price, use, fixtures, etc. General discussion follows. 9000 w. Am Gas Lgt Jour—May 4, 1903. No. 55041.

High Pressure.

Distributing Illuminating Gas at High Pressure. F. H. Shelton. Describes examples of high-pressure practice in America, showing the conditions for which it is particularly applicable and convenient. 1700 w. Cassier's Mag—May, 1903. No. 55179 B.

Leakage.

Excavations for Sewerage Purposes, and Unaccounted for Gas: An Experience. E. G. Smithard. Read before the East. Co's Gas Mgrs. Assn. An account of the damage done in King's Lynn, causing explosions, and of the legal settlement. General discussion. 5500 w. Gas Wld—April 25, 1903. No. 55006 A.

Mains.

Experiences with Cement Joints for Street Mains. B. F. Bullock. Gives the writer's experience in the use of cement joints. Prefers the lead joints. 1000 w. Am Gas Lgt Jour—May 25, 1903. No. 55339.

Mantles.

Testing the Strength of Mantles. Abstract of a paper by M. Syssoyeff before the Soc. Tech. du Gaz en France, describing an appliance for measuring the strength of gas-mantles. 1100 w. Jour Gas Lgt—May 19, 1903. No. 55500 A..

Oil-Gas.

Gas Making with Crude Oil in California. Information as to the use of crude oil in various gas-works in California, and the apparatus used. 1200 w. Jour Gas Lgt—April 28, 1903. No. 55120 A.

Photometry.

Relation Between French and German Methods of Photometry. A. Lecomte. Abstract translation of a paper read before the Société Technique du Gaz en France. An explanation of the methods used with discussion of tests made on the two photometers. Also editorial. 1800 w. Jour Gas Lgt—May 19, 1903. No. 55398 A.

Pyrogas.

The Suppression of Smoke and the Utilization of its Constituents (La Suppression Radicale de la Fumée et la Récupération de ses Eléments). E. Guarini. An illustrated description of M. Tobiansky d'Altoff's system in which he enriches the products of combustion, including smoke, with hydrocarbons, and uses the resulting gas for lighting, heating and power. 3500 w. Rev Technique—May 10, 1903. No. 55427 D.

Retort Charging.

The New Parisian Retort Charging-Machine and Discharging-Ram. Illustrated detailed descriptions of these machines and their operation, with comments and general information. 6500 w. Jour Gas Lgt—May 19, 1903. No. 55395 A.

Retort Stoking by Electricity. Particulars from a description appearing in the *Bulletin Technologique* of the Sarrosin system for charging and drawing retorts. Ill. 2500 w. Jour Gas Lgt—May 12, 1903. No. 55309 A.

Revivification.

Revivification in Situ, and Stopped Ascension-Pipes. A summary of interesting observations communicated by Herr Burgemeister to the *Journal für Gasbeleuchtung*. Describes a simple and economical method of supplying air for the revivification of the fouled oxide in purifiers. 1500 w. Jour Gas Lgt—May 5, 1903. No. 55262 A.

Secondary Air Heating.

Is the Zigzag Flue Necessary for Heating Secondary Air? J. Whyte. Read before the North of England Gas Mgrs. Assn. Gives results of experiments made. General discussion follows. Ill. 3800 w. Jour Gas Lgt—April 28, 1903. No. 55121 A.

Water Gas.

The Dellwick-Fleischer Process of Carburetting Water Gas by Passing It Into Retorts. Abstract translation of a paper read by M. Lecomte before the Soc. Tech. du Gaz en France. Descriptive. 2500 w. Jour Gas Lgt—May 19, 1903. Serial. 1st part. No. 55399 A.

Blue Water Gas and Its Enrichment by the Peebles Oil Gas Process. E. J. Brockway. Read before the East. Co's. Gas Mgrs. Assn. An account of writer's experience with a combination of a Dellwick plant for making blue water gas, with the Peebles process as an enricher. 7500 w. Gas Wld—April 25, 1903. No. 55007 A.

Utilizing Water Gas in the Production of Illuminating and Heating Gases. William Young. An account of personal experience and the results obtained; also gives extracts from a patent relating to improvements in the manufacture of illuminating gas. Ill. 5500 w. Jour Gas Lgt—May 5, 1903. No. 55261 A.

INDUSTRIAL ECONOMY

Accounting.

See Civil Engineering, Municipal; Electrical Engineering, Generating Stations; and Railway Engineering, Miscellany.

American Competition.

The American Peril and the Electrical Industry (Die Amerikanische Gefahr und die Elektrotechnische Industrie). Emil Honigmann. A discussion of the danger of American competition in Europe, particularly in the electrical industries, apropos of an article by H. L. Geissel in the *Electrical World and Engineer.* Statistical tables. 5000 w. Zeitschr f Elektrtechnik—March 22, 1903. No. 55468 D.

Carnegie Address.

Andrew Carnegie's Presidential Address to the Iron and Steel Institute. Extracts from the address in London, referring to the relations of capital and labor. 5800 w. Ir Age—May 7, 1903. No. 55081.

Consolidations.

See Electrical Engineering, Generating Stations.

Depreciation.

Sinking Fund Charges. W. H. Booth. A discussion of the best method of dealing with depreciation of a plant and buildings, and related matters. 3300 w. Tram & Ry Wld—April 9, 1903. No. 55018 B.

Education.

The Education of Engineers in America, Germany, and Switzerland. W. E. Dalby. Gives facts in connection with the training of engineers in the countries named as a basis for a discussion as to what course of training is best. 5000 w. Inst of Mech Engrs—April 24, 1903. No. 55165 D.

The Training of Engineers. Prof. Robert H. Smith. A discussion of the opportunities for scientific engineering education in Britain, noting the chief difficulties and defects of the present system. 4200 w. Engr, Lond—May 8, 1903. No. 55283 A.

Manchester Municipal School of Technology. From a paper by John T. Nicholsen before the Manchester Assn. of Engrs. Describes the steam engine laboratory in the present article. Ill. 2200 w. Mech Engr—May 9, 1903. Serial. 1st part. No. 55272 A.

See also Railway Engineering, Miscellany.

Employment.

The Employment Department of Employers' Association Work. J. C. Hobart. Address at the special convention of representatives of local employers' associations, held in Cincinnati under the auspices of the Nat. Metal Trades Assn. Considers the unions, the course of action for this association, etc. 4000 w. Ir Age—May 28, 1903. No. 55502.

Everett-Moore Syndicate.

The Winding Up of the Everett-Moore Syndicate. An outline of this syndicate, which gained control of the most remarkable groups of electric railway properties and independent telephone system, and of its downfall. 4500 w. St Ry Jour—May 2, 1903. No. 55099 D.

Foremen.

The Ideal Foreman. William Lodge. Address before the convention of local employers' associations at Cincinnati. Considers the requirements of a successful foreman, and gives suggestions. 8000 w. Ir Age—May 28, 1903. No. 55503.

Forestry.

See Civil Engineering, Materials.

Free Trade and Protection.

Free Trade and Protection (Freihandel und Schutzzoll). Karl Wittgenstein. An address giving a general discussion of the subject and the economic conditions of different countries. 8000 w. Zeitschd d Oesterr Ing u Arch Ver—March 20, 1903. No. 55476 B.

Industrial Efficiency.

The Promotion of Industrial Efficiency and National Prosperity. John B. C. Kershaw. A discussion of methods for bringing employers and employees into closer accord. This number gives brief descriptions of the plans in use at a large number of successful works in England, America, and on the Continent. 5500 w. The Engineering Magazine—June, 1903. No. 55-494 B.

Irish Bogs.

A Future for Irish Bogs. R. H. Sankey. Gives information of the nature, extent and calorific value of the bogs of Ireland, and describes a plan of utilizing them for the generation of electrical energy which can be transmitted and made available at an extremely low price. 3000 w. Nineteenth Cent—May, 1903. No. 55260 D .

Iron and Steel.

See Mining and Metallurgy, Iron and Steel.

Municipal Trading.

Municipal Trading. Robert P. Porter. The views of an advocate of private ownership for all public utilities. Compares European and American methods and results. 3500 w. Munic Jour & Engr—May, 1903. Serial. 1st part. No. 55038 C.

Municipal Socialism: Latest Development in Great Britain. Reprint of an article from the Liverpool *Daily Post,* giving a report of the development of "municipal trading" in Great Britain. 2000 w. U S Cons Repts, No. 1638—May 5, 1903. No. 55166 D.

Organization.

The Organization of Manufacturing Industries. Extracts from the presidential address of Andrew Carnegie at the annual meeting of the Iron & Steel Inst. 4000 w. Eng News—May 14, 1903. No. 55220.

Purchase.

Purchase by the Organized Factory. Horace L. Arnold. A concise description of a practical system, in regular use, for ordering supplies into the factory, checking their receipt and every issue by the stores keeper, and safeguarding the payment of every invoice. The system is simple and almost automatic. Illustrated. 3000 w. The Engineering Magazine—June, 1903. No. 55498 B.

Records.

A Work in Progress Record. Kenneth Falconer. Gives forms used by the writer to furnish a history of each productive order. 1000 w. Am Mach—May 28, 1903. No. 55510.

Research Institution.

Institution for Scientific Research (La Caisse des Recherches Scientifiques). Louis Rachou. An account of an institution founded and partly supported by the French government for promoting research work in medical, natural and physical science. 2500 w. Génie Civil—April 18, 1903. No. 54893 D.

Workmen's Dwellings.

Cheap Dwellings in France and Other Countries (Les Habitations à Bon Marché en France et à l'Etranger). E. Cacheux. A review of the question of low-priced dwellings for workmen, and an account of the operation of recent French laws. 1 plate. 5500 w. Mem Soc Ing Civils de France—March, 1903. No. 55409 C.

MARINE AND NAVAL ENGINEERING

Boilers.

See Mechanical Engineering, Steam Engineering.

Construction.

Some Points in the Construction of Large Steel Steamers and the Rivetting of Lapped Butts. Archibald Hogg. Read before the N.-E. Coast Inst. of Engrs. & Shipbuilders. The object of the paper is to call attention to the structural strength of large and full-formed steamers, and to suggest a new principle of lap butt rivetting. 2500 w. Engrs' Gaz—May, 1903. No. 55188 A.

Dredges.

See Civil Engineering, Canals, Rivers and Harbors.

Gasoline Fishing Boats.

Gasoline Engines for Fishing Boats (De l'Emploi des Moteurs à Pétrole à Bord des Bateaux de Pêche). J. Pérard. An illustrated account of the use of gasoline engines for propelling fishing vessels. 4000 w. Mem Soc Ing Civils de France—March. 1903. No. 55411 G.

Kaiser Wilhelm II.

The Latest Atlantic Liner, "Kaiser Wilhelm II." Brief illustrated description of this recently completed vessel, notable for her great size and power. 700 w. Sci Am—May 2, 1903. No. 55044.

Mammoth Ocean Greyhound. Illustrations and brief description of the Kaiser Wilhelm II, the latest German built trans-Atlantic express steamer. 700 w. Naut Gaz—April 30, 1903. No. 55040.

Lightships.

The New Lightships of the Coast of France. Translated from *La Nature*. Illustrations with brief descriptions. 1200 w. Sci Am Sup—May 23, 1903. No. 55317.

Minnesota.

Steamship Minnesota, of the Great Northern Steamship Company, Built by the Eastern Shipbuilding Company. Illustrated description of interesting features of construction and equipment of this mammoth ship. 8800 w. Marine Engng—May, 1903. No. 55046 C.

Giant Ships for Our Oriental Trade. F. N. Stacy. An interesting illustrated article describing the "Minnesota" and "Dakota." 2800 w. Rev of Revs—May, 1903. No. 55152 C.

Monitors.

A Comparison of the Trials of the New Monitors of the United States Navy. A summary from detailed reports of the four monitors recently authorized by Congress. The results are a valuable contribution to the subject of propeller design. 900 w. Marine Engng—May, 1903. No. 55050 C.

Propellers.

Plane Sections of the Blades of Screw Propellers (Le Sezioni Piane delle Pale d'Elica). A. Scribanti. A mathematical discussion of screw propellers, with diagrams and tables. 800 w. Rivista Marittima—March, 1903. No. 55491 H.

Railway Ferries.

Railway Trains on Ferries. Archibald S. Hurd. Describes and illustrates the ferry systems of Denmark, America, and other countries and discusses the use of such ferries across the English Channel. 4000 w. Cassier's Mag—May, 1903. No. 55181 B.

Reconstruction.

The Reconstructed New York. An interesting illustrated account of the work of bringing this well-known vessel up to the latest advances in marine engineering, and naval architecture, describing new features introduces. 1800 w. Marine Engng—May, 1903. No. 55051 C.

Refrigerated Cargoes.

Marine Installations for the Carriage of Refrigerated Cargoes. R. Balfour. Read before the Inst. of Nav. Archts. Describes the three systems of refrigeration most used, and discusses the construction of vessels best adapted, the design and arrangement of the holds in which the frozen cargo is carried. Ill. 6000 w. Engr, Lond—April 24, 1903. No. 55029 A.

Resistance.

On the Reduction of Wave-Making Resistance by a New Method. A letter from Walter Child, offering suggestions of a new method of reducing the wave-making resistance of vessels. 2800 w. Engng—May 1, 1903. No. 55202 A.

The Influence of Depth of Water on the Resistance of Ships. Charles P. Paulding. A study of the limiting economical speed of vessels in shallow water, and the determination of the least permissible depth for the contract trial of a given vessel required to make a given speed. 2000 w. Marine Engng—May, 1903. No. 55047 C.

Ship Design.

An Investigation of the Best Relations of the Depth and Draft of a Merchant Vessel to Its Beam (Ricerca dei Rapporti piu Convenienti dell' Altezza e dell' Immersione alla Larghezza di un Bastimento Mercantile). Ettore Mengoli. A discussion, partly mathematical, of the relations between the dimensions of ships, to secure minimum weight and resistance. 1200 w. Rivista Marittima—Feb., 1903. No. 55-488 H.

Trim.

A Special Trim Calculation. B. A. Sinn. Gives calculations made necessary by the arrangement of the interior. 800 w. Marine Engng—May, 1903. No. 55049 C.

Wrecking Work.

Wrecking Work of the Boston Towboat Company. Winthrop L. Marvin. An illustrated account of the work, with descriptions of the methods used, and reports of some of the vessels saved, with related matter of interest. 3300 w. Marine Engng—May, 1903. No. 55048 C.

Yachts.

The American Steam Yachts. W. P. Stephens. An interesting illustrated article reviewing its evolution and discussing its future development. 4500 w. Rudder—May, 1903. No. 55066 C.

The "Reliance" Under Sail. Gives views taken on the first trial of the new yacht, with descriptive notes. 1100 w. Sci Am—May 9, 1903. No. 55127.

MECHANICAL ENGINEERING

AUTOMOBILES.

Agricultural Motor.

The Ivel Agricultural Motor. Herbert C. Fyfe. Brief illustrated description of a motor constructed to draw reapers, plows, mowers, wagons, etc. Designed chiefly for the use of farmers. 800 w. Sci Am—May 30, 1903. No. 55521.

Darracq Vehicle.

The Light Darracq Vehicle (Le Voiture Légère Darracq). An illustrated description of a modern gasoline vehicle of the Darracq type. 700 w. Rev Technique—May 10, 1903. No. 55426 D.

Electric Carriages.

A Novel Electric Carriage. Illustrated description of a vehicle aiming at long wheel base, and low center of gravity. 900 w. Motor Car Jour—April 25, 1903. No. 55000 A.

The Waverley Electromobiles. Illustrates and describes a number of these light electric vehicles. 3200 w. Auto Jour—April 25, 1903. No. 55001 A.

Gordon-Bennett Race.

American Champions for the Gordon-Bennett Race. Hugh Dolnar. An illustrated account of the Long Island eliminating tests. 2800 w. Autocar—May 2, 1903. No. 55199 A.

The American Gordon-Bennett Champions. Hugh Dolnar. An illustrated article giving details of the vehicles chosen and brief account of the final trials. 2000 w. Autocar—May 9, 1903. No. 55266 A.

The Eliminating Trials. An illustrated account of the trials in England for the selection of cars for the Gordon-Bennett races. 1300 w. Autocar—May 2, 1903. No. 55198 A.

Winton Tries His Cup Racer. An illustrated description of the "Bullet II," with account of the trial. 1800 w. Automobile—May 16, 1903. No. 55238.

Horse-Power.

Horse Power at Various Speeds. Gives curves for seven weights of cars, showing power wanted for driving each at speeds above twelve miles per hour on the level and on grades. 700 w. Automobile—May 9, 1903. No. 55135.

Ignition.

The Eisemann and Bosch Systems of Electric Ignition. Drawings showing the general arrangement and principles of both these systems, with descriptive notes. 1500 w. Auto Jour—May 9, 1903. No. 55268 A.

Mercedes Car.

The 60 h. p. Mercedes. An illustrated article describing details of these cars. 1000 w. Autocar—May 16, 1903. Serial. 1st part. No. 55358 A.

Petrol Cars.

The Crouan Petrol Car. An illustrated article describing the recent cars of this French firm. 2000 w. Auto Jour—May 16, 1903. Serial. 1st part. No. 55359 A.

The Rochet-Schneider 16-20-H. P. Petrol Car—1903 Type. Illustrated detailed description. 3300 w. Auto Jour—May 9, 1903. No. 55267 A.

The "Spyker" Petrol Car. Illustrates and describes a car exhibited at the recent exhibition at Agricultural Hall. These cars were made in Holland. 800 w. Motor Car Jour—May 9, 1903. No. 55269 A.

Racing Cars.

French Racing Motor Cars. Remarks on the effect of the accident at the recent meeting at Nice on the future of motor car racing, with discussion of the benefits from the races, and illustrated descriptions of the more remarkable of the cars entered. 2400 w. Engr, Lond—April 24, 1903. No. 55027 A.

Railway Vehicles.

Gasoline Vehicles for Railways (Quadricycle et Wagonette à Pétrole pour la Circulation sur les Lignes de Chemins de Fer). L. Pierre-Guédon. An illustrated description of a quadricycle and a wagonette with petrol motors, for regular railway service. 800 w. Génie Civil—April 18, 1903. No. 54892 D.

Serpollet.

The Serpollet Steam Automobile. Begins an illustrated detailed description. 800 w. Sci Am Sup—May 16, 1903. Serial. 1st part. No. 55247.

Starting Motors.

The Starting of Gasoline Engines (Les Moteurs à Pétrole Mise en Marche). M. Réperti. An illustrated account of starting devices for internal-combustion motors and methods of getting the latter going. 2000 w. Rev Technique—April 25, 1903. No. 55422 D.

Torbensen Gear.

The Torbensen Transmission System. Herbert L. Towle. Illustrated description of the running gear designed by V. V. Torbensen. 2000 w. Automobile—May 9, 1903. No. 55136.

Tractive Resistance.

The Tractive Power of Automobiles (Automobilisme: L'Effort de Traction dans les Voitures Automobiles). A discussion of the tractive power and resistance of automobiles on various pavements, with diagrams and tables. 2500 w. Rev Technique—March 25, 1903. No. 55417 D.

HYDRAULICS.

Pumps.

See Mechanical Engineering, Special Motors.

Pump Valves.

The Valve Motions in Reciprocating Pumps (Etude du Mouvement des Clapets dans les Pompes à Mouvement Alternatif). C. Enquehard. A study of the action of the valves of high-speed reciprocating pumps, with diagrams. 600 w. Rev de Mécanique—April 30, 1903. No. 55403 E + F.

Turbine Tests.

Brake Tests of a Radial Turbine (Bremsversuche an einer Radialturbine, Gebaut von der Maschinenfabrik Briegleb, Hansen & Co., in Gotha). Prof. Pfarr. An illustrated account of a test of a German turbine and comparison with test of a "New American" turbine of the same size and using about the same volume of water. Diagrams and tables. 700 w. Zeitschr d Ver Deutscher Ing—May 2, 1903. No. 55449 D.

A Prony Brake Test of a Horizontal Turbine for the Bates Mfg. Co., Lewiston, Me. William O. Webber. An illustrated account of tests made to determine if a pair of horizontal turbine water-wheels fulfilled a guaranteed performance of 688 brake horse-power at 223 revolutions per minute and 27 ft. of head. 800 w. Eng News—April 30, 1903. No. 55088.

MACHINE WORKS AND FOUNDRIES.

Axles.

Hollow Pressed Axles. Camille Mercader. Read at meeting of the Iron and Steel Inst. Gives the method proposed by the writer, reporting experiments, tests, etc., and describing the hydraulic axle forging machine. Gives advantages claimed. Ill. 4200 w. Ir Age—May 7 and 14, 1903. Serial. 2 parts. No. 55079.

Hollow Pressed Axles. Camille Mercader. Extracts from a paper read at meeting of the Iron and Steel Inst. Describes the method proposed by the writer for making by pressure, axles having varying diameters. Also reports experiments made regarding material for the punches, and other details of the work. Ill. 2500 w. Can Engr—May, 1903. No. 55036.

Castings.

Common Methods of Altering Old Patterns. An illustrated article suggesting changes that may be made oftentimes in patterns so that they may serve for different castings and so lessen expense. 1500 w. Prac Engr—April 24, 1903. No. 55003 A.

Melting Steel with Cast Iron. R. P. Cunningham. Read before the New England Found. Assn. Describes the method of charging the cupola, and the proper management to give castings of a required strength. 1200 w. Foundry—May, 1903. No. 55173.

Chucks.

Bench Lathe Chucks and Attachments for Operating Them. Jos. M. Stabel. Illustrates and describes several chucks, and the devices for operating them. 900 w. Am Mach—May 7, 1903. No. 55104.

Coining.

Coining Machinery in Chinese Mints. Oberlin Smith and Henry A. Janvier. An account of the installation of plants for producing certain issues of coins for the Chinese Government. Gives information in regard to the customs of the country, describing journey into the interior. Ill. 3400 w. Cassier's Mag—May, 1903. No. 55176 B.

Core Boxes.

Core Boxes for Globe Valves. Robert Wagner. Illustrates and describes a method in which only two core boxes are used and two cores give one complete valve. 400 w. Foundry—May, 1903. No. 55174.

Cores.

Core-Making Machine. Illustrated description of a machine intended for producing complicated cores. 800 w. Engng—April 24, 1903. No. 55024 A.

Dies.

A New Opening Die. Illustrates a new die intended for turret lathe work and possessing novel features. 1100 w. Am Mach—May 7, 1903. No. 55101.

Drilling.

Experiments upon the Work of Machine Tools—Drill Shavings (Expériences sur le Travail des Machines-Outils—Copeaux de Forage). M. Codron. A profusely illustrated study of the shavings cut by different kinds of drills from various metals, forming a continuation of the author's investigations on machine tools. 5000 w. Bull Soc d'Encour—April 30, 1903. No. 55402 G.

A Large Drilling Machine. General view and brief description of a fine machine recently made in England. 500 w. Engr, Lond—May 8, 1903. No. 55284 A.

Foundry Management.

Foundry Management in the New Century. VII. The Qualities and Training of the Foundry Manager. Robert Buchanan. Concluding a series by a very sound and interesting statement of existing labor conditions and tendencies which the foundry manager must meet and control, and the policy which will prove successful. 2500 w. The Engineering Magazine—June, 1903. No. 55499 B.

Gaggers.

Gaggers. James A. Murphy. On the usefulness of gaggers in the foundry, with an illustrated description of a machine for making them. 1200 w. Foundry—May, 1903. No. 55172.

Grinding.

Some More Points About Grinding. C. H. Norton. Discusses points brought up by Tecumseh Swift and F. Thornley, and gives personal experiences. 4200 w. Am Mach—May 7, 1903. No. 55100.

Hunt Methods.

Hunt's Measurements and Drawings. John Randol. The first of a series of illustrated articles describing the method of making measurements in machine work used by the C. W. Hunt Company. 2800 w. Am Mach—May 21, 1903. Serial. 1st part. No. 55299.

Lathe.

Motor-Driven Shafting Lathe. Illustrations and description of a recently designed lathe having points of interest. It is driven by an 18 h. p. variable speed motor. 800 w. Am Mach—May 28, 1903. No. 55509.

Machine Design.

Elements of Successful Machine Design. Ralph Scott. Considers various factors with respect to their relation to design, and gives rules to be borne in mind by designers. 3000 w. Elec, N. Y. —May 20, 1903. No. 55297.

Machine Tools.

Modern American Machine Tools. Charles H. Benjamin. A discussion of the problem from the standpoint of a designer, considering the architectural and utilitarian sides. Ill. 2500 w. Cassier's Mag—May, 1903. No. 55177 B.

Milling Keys.

Milling Keys. Illustrates and describes special tools constructed in such a way that by making a few changes the tool will answer for several sizes. 1400 w. Am Mach—May 7, 1903. No. 55103.

Notching Machine.

A Machine for Cutting Notches in Railroad Ties (Machine à Saboter les Traverses de Chemins de Fer). An illustrated description of a machine for quickly cutting notches in wooden cross ties for the rails to rest in. 1 plate. 1500 w. Génie Civil—March 21, 1903. No. 54883 D.

Order System.

An Order System for Foundries. J. Byron Henry. Outlines methods for keeping record of foundry orders in shops with a large output that make a specialty of jobbing orders. 1200 w. Foundry—May, 1903. No. 55175.

Patterns.

Numbering and Storing Patterns. S. A. Worcester. Considers the arrangement of shelves, and describes the system recommended. 1000 w. Am Mach—April 30, 1903. No. 54987.

Printing-Press Factory.

The Printing-Press Factory of Koenig and Bauer, near Würzburg, Germany (Die Schnellpressenfabrik von Koenig & Bauer in Kloster Oberzell bei Würzburg).

An illustrated description of the new works of this old firm, which has manufactured high-speed printing presses for nearly 100 years. 5500 w. Zeitschr d Ver Deutscher Ing—April 18, 1903. No. 55-444 D.

Racks.

Cutting Racks—Approximate Sizing of Gear Blanks. Illustrates and describes the solution of the problem as worked out by the Cincinnati Planer Company. 1200 w. Am Mach—May 7, 1903. No. 55102.

Reamers.

The Construction and Working of Machine Reamers and Reaming Heads. E. Bruce Ball. The present article gives illustrated descriptions of various types of reamers and their work, explaining their economy and reliability. 3500 w. Engng —May 8, 1903. Serial. 1st part. No. 55280 A.

Rivets.

Concerning Rivet Heads. Gives a table for the various diameters of rivets, showing the proper projections through the plates to be joined, illustrating its use by examples. 1500 w. Locomotive—Feb., 1903. No. 55167.

Sheet-Metal Work.

Manufacturing Armature Disks and Segments. Joseph V. Woodworth. Illustrated description of dies, presses and special machinery for this work. 1800 w. Mach, N. Y.—May, 1903. No.. 55-106 C.

Swaging.

Swaging Machines and the Cold Swaging Process. Illustrates and describes several swaging machines and their work, and discusses uses made of this process. 2500 w. Mach, N. Y.—May, 1903. No. 55105 C.

Tools.

Tools and Gauges in the Modern Shop. H. F. L. Orcutt. Abstract of a paper read before the Inst. of Engrs. and Shipbuilders in Scotland. Considers important items to the successful introduction of improved equipment in shops. 5000 w. Mech Engr—April 25, 1903. No. 55005 A.

Tool Steels.

High-Speed Tool Steels. William Lodge. Read at recent meeting of Cincinnati Machine Tool Mfrs. Gives suggestions for the use of high-speed steels on cast iron, and the general operation of these tools. 1400 w. Ir Trd Rev—May 21, 1903. No. 55302.

High-Speed Metal Cutting. Oberlin Smith. Discusses the recent improvements in tool steel, and the consequent improvement needed in machine-tool design; considers the planer problem. 2000 w. Am Mach—May 21, 1903. No. 55301.

MATERIALS OF CONSTRUCTION.

Alcohol.

Alcohol for Industrial Purposes. Reviews the results accomplished in the use of alcohol for heat, light and power. 2000 w. Mach, N. Y.—May, 1903. No. 55107 C.

Decay of Metals.

The Decay of Metals. J. T. Milton and W. J. Larke. Abstract of a paper read before the Inst. of Civ. Engrs. Discusses cases of decay and the probable causes. 1500 w. Sci Am Sup—May 16, 1903. No. 55245.

Wire Rope.

The Invention, Properties and Future of Wire Rope (Das Drahtseil, seine Erfindung, Eigenschaften und Zukunft). Prof. O. Hoppe. A historical and descriptive discussion of wire rope and its uses. 5500 w. Glückauf—April 4, 1903. No. 55438 D.

MEASUREMENT.

Bending Moments.

Bending Moments Not in the Same Plane. H. F. Moore. Presents a phase of a problem in machine design frequently encountered, describing method used. Ill. 1000 w. Sib Jour of Engng—May, 1903. No. 55191 C.

Copper Tests.

Breaking Tests with Long Continued Heating. The Behavior of Copper (Der Warmzerreissversuch von Langer Dauer. Das Verhalten von Kupfer). Prof. R. Stribeck. A well illustrated account of tension tests of copper bars subjected to high temperatures for long periods in an electric oven. 4000 w. Zeitschr d Ver Deutscher Ing—April 18, 1903. No. 55-445 D.

Expansion.

The Expansion of Steel at High Temperatures (Recherches sur la Dilatation des Aciers aux Températures Elevées). G. Charpy and L. Grenet. An illustrated account of elaborate researches on the expansion and other properties of steel at high temperatures, particularly about 700° C., the "recalescence" point. Diagrams and tables. 8000 w. Bull Soc d'Encour—April 30, 1903. No. 55401 G.

Friction Tests.

Coefficients of Friction between Wood and Iron (Reibungs-Koeffizienten zwischen Holz und Eisen). Prof. L. Klein. An account of friction tests made with iron and various kinds of wood, with particular reference to brakes for mine hoisting apparatus. 2 plates. 2500 w. Glückauf—April 25, 1903. No. 55441 D.

Metric System.

The Metric System in the Machine

Shop. Views of August Hoffmann on the relative merits of inch measurements and the metric system, favoring the latter. 800 w. Am Mach—May 14, 1903. No. 55234.

Standards.

Weights and Measures. Prof. S. W. Stratton. Reviews what has been done by the U. S. government in regard to fixing standards of weights and measures, describing the functions of the National Bureau of Standards and the work. General discussion. 6500 w. Pro Engrs' Soc of W Penn—March, 1903. No. 55290 D.

Steel Tests.

Soft vs. Hard Steel as a Structural Material (Weiches und Hartes Flusseisen als Konstructionsmaterial). F. R. Eichhoff. An account of an elaborate series of tests which were made at the Krupp Works to determine the relative merits of soft steel and hard steel as structural materials. Tables. 5 plates. 5000 w. Stahl u Eisen—April 15, 1903. No. 55430 D.

POWER AND TRANSMISSION.

Air Compressors.

Air Compressors for Mining Operations (Luftkompressoren im Zechenbetriebe). An account of tests of many air compressors made by the Boiler Inspection Association of the Mines in the Dortmund District, Germany, with many illustrations and diagrams. 6 plates. 8000 w. Glückauf—March 28, 1903. No. 55437 D.

See also Mining and Metallurgy, Coal and Coke.

Belting.

Hints on Leather Belting. W. H. Kritzer. Gives suggestions for arrangement and location of belts, and rules for finding length of belt needed, horse-power, speed, and width. Ill. 1200 w. Min & Sci Pr—April 25, 1903. No. 55045.

Cranes.

Modern Crane Construction. George William Rushworth. An illustrated article describing various types. 4500 w. Feilden's Mag—May, 1903. Serial. 1st part. No. 55378 B.

Flywheels.

The Design of Flywheels. A. Kemp. Discusses things that must be taken into consideration in the designing of flywheels and gives method of plotting diagrams. 1600 w. Feilden's Mag—May, 1903. No. 55375 B.

Ore-Carrying.

The Handling and Storing of Iron Ore. Charles Piez. Considers how a great reduction in cost has been brought about by labor-saving appliances. General discussion. 4000 w. Pro Engrs Club of Phila—April, 1903. No. 55162 D.

SPECIAL MOTORS.

Compound Engines.

Some Remarks on the Compound Explosion Engine. E. Butler. Gives an illustrated description of an engine designed by the writer, demonstrating the behavior of the explosive gases. 1600 w. Feilden's Mag—May, 1903. No. 55377 B.

Crude Oil.

The Application of Crude Oil to Gas Engines. Frank H. Bates. A study of the methods of gasification of crude oil for the gas engine. Ill. 7700 w. Jour of Elec—May, 1903. No. 55507 C.

Dunlop Engine.

Dunlop's Reversible Self-Starting Internal-Combustion Engines. The illustrations show a launch engine. The arrangement and operation are fully described. 2500 w. Mech Engr—May 9, 1903. No. 55270 A.

Explosion Pressures.

Investigations of the Pressures in Closed Vessels Due to the Explosion of Hydrogen and of Carbonic Oxide (Untersuchungen über die Drücke, welche bei Explosionen von Wasserstoff und Kohlenoxyd in Geschlossenen Gefässen Auftreten). Dr. Arnold Langen. An illustrated account of experiments on the thermodynamic phenomena with explosive mixtures of gases, such as are used in internal-combustion motors. Tables and diagrams. 4000 w. Zeitschr d Ver Deutscher Ing—May 2, 1903. No. 55-448 D.

Gas Engine.

A Combined Gas and Steam Engine (Moteur à Gaz et à Récupération des Calories Actuellement Perdues). Jules Garnier. An illustrated description of an internal-combustion engine, in which the cooling water is injected into the cylinder and there vaporized, the steam performing useful work on the piston. 2800 w. Mem Soc Ing Civils de France —March, 1903. No. 55407 G.

Diagnosing Gas Engine Ills. An outline of the principles which govern the action of these motors. The present article discusses the subject of ignition. 1600 w. Automobile—May 23, 1903. Serial. 1st part. No. 55337.

Recent Developments in Gas Engines. A. V. Coster. Considers the great changes due to the manufacture of cheap gas, and changes in the design of gas engines. Particularly considering large gas engines of 500 brake h. p. and upwards. Ill. 1500 w. Prac Engr—April 24, 1903. Serial. 1st part. No. 55004 A.

Gasoline Engines.

See Marine and Naval Engineering.

Gas Power.

The Economical Generation and Distribution of Power in Large Works. A. Rollason. Read before the W. of Scotland Iron and Steel Inst. Gives facts aiming to show that gas power is the most economical for all purposes. 3000 w. Ir & Coal Trds Rev—April 24, 1903. No. 55021 A.

Ignition.

See Mechanical Engineering, Automobiles.

Kerosene Engine.

A Simple Kerosene Engine. Illustrated description of a new type having the merit of simplicity. 1400 w. Sci Am—May 23, 1903. No. 55312.

Pumping Station.

A Gas Engine Pumping Station. An illustrated description of the plant of the Pittsburg Glass Company, at Ford City, Pa. 1800 w. Eng Rec—May 23, 1903. No. 55355.

Rotary Engine.

The Primat Alternating Rotary Engine (Le Moteur Alterno-Rotatif Primat). An illustrated description of a rotary engine with four cylinders, which can be used as an internal-combustion engine, a steam or vapor engine, or a compressed-fluid engine. 1200 w. Rev Technique—May 10, 1903. No. 55425 D.

Starting Motors.

See Mechanical Engineering, Automobiles.

STEAM ENGINEERING.

Boiler Explosion.

An Interesting Boiler Explosion. A. H. Smith. An illustrated account of the explosion at the Republic Iron & Steel Co.'s plant in Toledo, Ohio, which was probably due to the leaving of a 6-in. valve closed after cleaning, and its sudden opening. 1000 w. Eng News—May 7, 1903. No. 55139.

Boilers.

The Construction of Seamless Boilers. G. Lentz. Illustrated description of the apparatus for producing the hollow-tubular bodies by the Ehrhardt hydraulic pressing process. 1600 w. Am Engr & R R Jour—May, 1903. No. 55075 C.

Circulation in Shell Boilers. William Thomson. Read before the Inst. of Mech. Engrs. Considers the circulation of all fluids connected with shell boilers, as well as the heat which goes to produce the final result. 5000 w. Naut Gaz—May 21, 1903. No. 55340.

The Boiler Problem in the Navy. Discusses the cause of the trouble in the "Maine," believing the injuries due to the type of boiler. General discussion of the water-tube boiler problem. 2500 w. Ir Age—May 7, 1903. No. 55080.

A Double Drum Boiler. A brief illustrated description of the Robb-Mumford boiler. 1000 w. Eng Rec—May 9, 1903. No. 55150.

The Choice of a Steam Boiler. C. E. Stromeyer. Abstract of a paper read before the Civ. & Mech. Engrs. Soc., England. A discussion of types, giving a tabulated comparison of boilers as regards evaporation per space occupied. 2000 w. Mech Engr—May 16, 1903. No. 55362 A.

Yarrow Boilers (Generatori di Vapore Yarrow). Bruzzone Attilio. An illustrated description of the Yarrow express boilers on the first class torpedo boat "Condore," and an account of experience with them. 8000 w. Rivista Marittima—Feb., 1903. No. 55487 H.

Boiler Scale.

Formation of Boiler Scale from Fresh Waters and Its Prevention. Dr. J. Ohly. Discusses methods of purifying the water before bringing it into the boiler. 1800 w. Min Rept—April 30, 1903. No. 55037.

Corliss Engine.

Corliss' First Compound Pumping Engine. An account of this engine as given in a recent paper by George R. Phillips, with illustrations. 600 w. Power—May, 1903. No. 55068 C.

Dinnendahl.

Franz Dinnendahl. A Steam Engine Centennial (Franz Dinnendahl. Ein Hundertjähriges Dampfmaschinen-Jubiläum). Conrad Matschoss. An illustrated biographical sketch of Franz Dinnendahl, about the first steam-engine builder in western Germany, and descriptions of his early pumping engines for mines. 6000 w. Zeitschr d Ver Deutscher Ing—April 25, 1903. No .55447 D.

Düsseldorf Exposition.

Steam Engines at the Düsseldorf Exposition (Les Machines à Vapeur à l'Exposition de Düsseldorf). P. F. Dujardin. An illustrated description of some steam engines and auxiliary apparatus exhibited at Düsseldorf, in 1902. 1 plate. 2200 w. Génie Civil—April 25, 1903. No. 54894 D.

Electric Plants.

Steam Practice in American Electric Light and Power Plants. George H. Barrus, George I. Rockwood, H. C. Meyer, Jr., and Charles W. Oliver. Articles by the above authors, dealing with boiler practice, piping, engines, etc. Ill. 9500 w. Am Elect'n—June, 1903. No. 55527.

American Steam Engines for Electric Light and Power Service. H. F. Schmidt. Illustrated descriptions of many modern types. 16500 w. Am Elect'n—June, 1903. No. 55528.

Epicycloidal Engine.

The Cooley Epicycloidal Steam Engine. Illustrates and describes a new type of rotary engine and the principle of its construction. 1400 w. Mach, N. Y.—May, 1903—No. 55108 C.

Feed Water.

Feed Water for Boilers (Ueber Kesselspeisewasser). Hr. Bracht. An account of feed waters, their impurities and methods of purification. 1500 w. Glückauf —March 14, 1903. No. 55436 D.

Water for Locomotive Boilers. William M. Jewell. Notes on the selection and application of water in a boiler, and related matter. 1500 w. R R Gaz—May 15, 1903. No. 55214.

Hoisting Engine.

The Steam Consumption of a Hoisting Engine at the Emscher Mine, in the Cologne District, Germany (Bestimmung des Dampfverbrauchs an der Fördermaschine auf Schacht Emscher des Kölner Bergwerks-Vereins). An account of a test made by the Boiler Inspection Association of the Mines in the Dortmund District, Germany, with diagrams. 1000 w. Glückauf—April 18, 1903. No. 55440 D.

Injected Water.

Temperature Tests of Injected Water. H. M. Wickhorst. An illustrated article describing tests made to determine whether the water fed into a locomotive by the injector, having greater specific gravity, does not flow to the bottom of the boiler. Also suggests two methods of getting a better mixture of injected water. 1500 w. Ry Age—May 22, 1903. No. 55342.

Oil Fuel.

Crude Oil as a Fuel. A. M. Hunt. Paper read before the California Miners' Assn., San Francisco, Nov., 1902. Facts from the writer's experience relating to the use, efficiency, cost, etc. Ill. 4500 w. Jour of Elec—May, 1903. No. 55508 C.

On the Use of Beaumont Oil as Fuel. Henry H. Humphrey. Discusses the advantages and disadvantages of oil fuel, and the questions relating to its use. 3800 w. Jour Assn of Engng Soc's—March, 1903. No. 55157 C.

Pipe Coverings.

Pipe Coverings. R. T. Strohm. Discusses in the order of their importance the special requirements of a good pipe covering. 2500 w. Am Elect'n—May, 1903. No. 55111.

Piston Rings.

Piston Rings of Steam Engines (Conditions d'Etablissement des Anneaux de Piston des Machines à Vapeur). E. Déthiollaz. An illustrated discussion of the pressures on, and proper dimensions of, piston rings to avoid unnecessary strains. 1300 w. Rev Technique—March 10, 1903. No. 55415 D.

Reheaters.

The Use of Reheaters in Compound Engines. Abstract of a paper by George H. Barrus, read before the New England Cotton Mfrs. Assn., giving valuable data based on tests by the author. 1700 w. Eng Rec—May 9, 1903. No. 55149.

Rotary Engine.

A Curious Rotary Engine. Joseph Riley. Photograph and sectional model with brief description. 1200 w. Engr, U S A—May 1, 1903. No. 55083 B.

Steam Turbines and Rotary Engines. Principally a description of the Hult rotary engine and its working. 2000 w. Am Mach—May 21, 1903. No. 55300.

The Hult Rotary Steam Engine. An illustrated description of the construction and working of a novel engine. 2000 w. Elec Rev, Lond—May 1, 1903. No. 55196 A.

Smoke Prevention.

See Gas Works Engineering; and Mechanical Engineering, Miscellany.

Steam Blows.

The Location of Steam Blows in Tandem Compound Locomotives. F. P. Roesch. Instructions, with illustrations showing sections through steam chests, valves, and cylinders with valves in various positions for testing. 700 w. Ry Mas Mech—May, 1903. No. 55065.

Steam Turbines.

Recent Steam Turbine Applications with Data of Performances. Hon. G. L. Parsons. Outlines the improvements made in the Parsons turbines, and illustrates and describes recent applications. 3000 w. Cassier's Mag—May, 1903. No. 55182 B.

Steam Turbines (Le Turbine a Vapore). Alberto Pacchioni. An illustrated historical and descriptive review of steam turbines. 11000 w. Rivista Marittima—March, 1903. No. 55490 H.

Superheated Steam.

Tests of a Belgian Engine Using Superheated Steam. Reports a series of tests made by Prof. M. Schroeter of Munich on a van den Kerchove engine. The object was to study the behavior of the engine with saturated and superheated steam under different conditions. Ill. 1600 w. Am Elect'n—May, 1903. No. 55110.

Valve Gear.

Valve Gear of the Porter-Allen Engine. Illustrated description. The special feature is the use of a link, actuated by a single eccentric and driving independently the steam and exhaust valves. 2300 w. Power—May, 1903. No. 55069 C.

Water in Steam.

Water in Steam. James Andrews. Read before the Glasgow Tech. Col. Sci Soc. Gives rules for calculating the rate of expansion, the dimensions of cylinders, mean pressure, etc., and discusses steam jackets, and means of securing economy in steam consumption in the present article. 2000 w. Mech Engr—May 16, 1903. Serial. 1st part. No. 55363 A.

MISCELLANY.

Aeronautics.

Aeronautics (L'Aéronautique). Jean de Villethiou. Various notes on aeronautics, with illustrations. Serial. 2 parts. 2000 w. Rev Technique—March 10 and 25, 1903. No. 55414 each D.

Aerial Progress. Describes the trials of M. M. Lebaudy's navigable balloon, and M. Santos Dumont's No. 9 airship. Both were very successful. Ill. of the latter. 1200 w. Auto Jour—May 16, 1903. No. 55360 A.

Air Buffers.

The Air Buffer. Ernest R. Briggs. Illustrates and describes the air buffer of the Willans engine, and discusses various applications. 2400 w. Am Mach—April 30, 1903. No. 54988.

Arithmograph.

The Arithmograph, a Calculating Machine (Sur un Calculateur, Mécanique Appelé Arithmographe). M. Troncet. An illustrated description of an apparatus which will perform mechanically all arithmetical operations. 400 w. Comptes Rendus—March 30, 1903. No. 54-872 D.

Education.

See Industrial Economy.

Heating and Ventilation.

Ventilation and Heating in the New Government Building at San Francisco. Describes the system used in the San Francisco post-office and court-house building. The air is heated by hot water and supplied by plenum fans; the foul air being removed by exhaust fans. 2800 w. Eng Rec—May 2, 1903. No. 55119.

The Heating and Ventilating Plant of the New Swiss Parliament Buildings in Bern (Die Heizungs und Lüftungsanlagen des Neuen Schweizerischen Bundeshaus in Bern). A description, with plans and figures, of an extensive heating and ventilating system installed by Sulzer Brothers, of Winterthur, Switzerland. Serial. 2 parts. 4000 w. Schweiz Bauzeitung—March 21 and 28, 1903. No. 55483 each D.

Refrigerating Machine.

Efficiency Tests of Linde Ice Machines (Leistungsversuche an Linde-Maschinen). E. Brauer. An account of tests on Linde refrigerating machines at two German breweries. 1500 w. Zeitschr d Ver Deutscher Ing—May 9, 1903. No. 55-451 D.

Refrigeration.

A Cold Storage Warehouse. An illustrated description of the conversion of a brewery in Rochester, N. Y., into a cold storage plant. The system of refrigeration makes use of a circulation of chilled air to the rooms to be cooled. 2000 w. Eng Rec—May 18, 1903. No. 55232.

The Necessary Apparatus for Mechanical Refrigeration. Oswald Gueth. A lecture delivered before the James Watt Assn., No. 7, N. A. S. E. An illustrated article discussing the apparatus used in ammonia compression plants, the diversity found, the different systems, and related subjects. 6300 w. Engr, U S A—May 1, 1903. No. 55082 B.

See also Marine and Naval Engineering.

Smoke.

Smoke and the Determination of its Density. Albert A. Cary. Abstract of a paper read before the New England Cotton Mfrs. Assn. Describes the production of coal gas, showing why soot is greasy and sticky, and the cause of smoke, in the present number. 3000 w. Elec Rev, N. Y.—May 23, 1903. Serial. 1st part. No. 55514.

Smoke and Gas.

The Effect of Smoke and Gas upon Vegetation. W. A. Buckhout. Considers the elements that cause injuries and the difficulties in determining their presence in many cases. 4800 w. Mines & Min—May, 1903. No. 55056 C.

Smoke Prevention.

Two Experiments in Smoke Preventing Furnaces. Illustrates and describes two devices for securing improved combustion in boiler furnaces. One the invention of J. B. Harris; the other of Robert L. Walker. 1900 w. Eng News—May 21, 1903. No. 55321.

The Wilskemp Smoke Consumer. Illustrated description of a recent English invention. 1000 w. Engr, Lond—May 8, 1903. No. 55286 A.

See also Gas Works Engineering.

Sugar Refinery.

The New Plant of the Sugar Works at Cambrai, France (Les Installations Nouvelles de la Sucrerie Centrale de Cambrai, à Escaudoeuvres). A well illustrated description of a beet-sugar refinery, equipped with modern machinery, including an electric plant. Serial. 2 parts. 1 plate. 5000 w. Génie Civil—April 18 and 25, 1903. No. 54891 each D.

Windmills.

The Royal Agricultural Society's Windmill Trials. An illustrated description of the mills and an account of the nature of these important trials. 11000 w. Engr, Lond—May 1, 1903. No. 55204 A.

Wind-Engines at the Royal Agricultural Society's Ground, Ealing. Illustrated descriptions of several types of engines sent in for competition for the series of trials of wind-engines for pumping. 3300 w. Engng—April 24, 1903. No. 55025 A.

MINING AND METALLURGY

COAL AND COKE.

Anthracite.

The Coal Industry of Pennsylvania. W. Frank M'Clure. Remarks on the rapid development during recent years, with information concerning the mines and methods. Ill. 2500 w. Sci Am—May 23, 1903. No. 55314.

Boiler Fuel.

Coal as a Boiler Fuel. E. B. Wilson. Discusses the comparative values of carbon and volatile matters for steam making, and the different causes of incomplete combustion. 1500 w. Mines & Min—May, 1903. No. 55063 C.

Coal Cutting.

Chain and Pick Coal Cutting Machines. An illustrated article comparing the two types from the standpoint of an advocate of chain machines. 2000 w. Min Rept—May 7, 1903. No. 55131.

Coal Washing.

A Modern Method of Coal Washing. C. A. Meissner. Read before the Nova Scotia Min. Soc. Illustrated description of the Campbell coal washing table. 1500 w. Eng & Min Jour—May 9, 1903. No. 55144.

Coke Ovens.

The Development of the Modern By-Product Coke-Oven. Christopher G. Atwater. Describes and discusses the progress made to the present date, in the development of the modern by-product coke-oven. Ill. 3300 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 55384 C.

Dortmund.

The Report for 1902 of the Association of the Mining Industry in the Dortmund District, Germany (Jahresbericht des Vereins für die Bergbaulichen Interessen im Oberbergamtsbezirk Dortmund für das Jahr 1902). A report, with many statistics, on the production of coal, coke and briquettes, transportation, mining, wages, etc., with comparative tables and diagrams. 3 plates. 7000 w. Glückauf—April 11, 1903. No. 55439 D.

Electrical Machinery.

See Electrical Engineering, Power Applications.

Hauling.

Compressed-Air Motors for Gathering Cars in Coal-Mines. Beverley S. Randolph. Gives a comparison of motors and mules used in gathering cars from working-places; and the comparative cost. Ill. 1000 w. Trans Am Inst of Min Engrs—Feb., 1903. No. 55389.

Irish Bogs.

See Industrial Economy.

Japan.

The Yubari Coal Mines in Japan. Gives the history, geology, methods of mining, and an illustrated description of the plant for preparing the coal. 1300 w. Mines & Min—May, 1903. No. 55053 C.

Kansas Coal Field.

The Weir-Pittsburg District of the Kansas Coal Field. Prof. W. R. Crane. A description of the district, the methods employed, and of a typical mine and tipple. Ill. 3700 w. Mines & Min—May, 1903. No. 55054 C.

Louisiana Purchase.

Coal Resources of the Louisiana Purchase. Frederick E. Saward. Notes relative to the traffic in coal within the area of country comprised within the celebrated Louisiana Purchase. 2200 w. Ir Age—May 28, 1903. No. 55501.

Shipping Appliances.

English Shipping Appliances for Coal. Illustrates and describes the methods of shipping export coal, used in the Northumberland and Durham centers and in South Wales. 2000 w. R R Gaz—May 1, 1903. No. 55092.

Working.

Some Points in the Working of a Non-fiery, Naturally Wet House Coal Seam. Discusses some of the difficulties and disturbances of small workings. 1700 w. Ir & Coal Trds Rev—May 15, 1903. No. 55372 A.

COPPER.

Analysis.

The Commercial Analysis of Copper Ore. Russell L. Dunn. Gives some interesting figures of profit and loss, and discusses the problem of profitable reduction. 3000 w. Pacific Coast Miner—May 9, 1903. No. 55224.

Arizona.

The Copper Deposits of Clifton, Arizona. Waldemar Lindgren. Describes the topography, geology, structure, ore deposits, and fissure veins. Ill. 2800 w. Eng & Min Jour—May 9, 1903. No. 55143.

Butte, Montana.

The Synthesis of Chalcocite and Its Genesis at Butte. Horace V. Winchell. Shows that chalcocite is the principal copper mineral of this region, and gives an experimental study showing how it was formed. 3300 w. Eng & Min Jour—May 23, 1903. No. 55349.

Nickel-Copper Ores.

See Mining and Metallurgy, Miscellany.

Smelting.

Smelting of Raw Sulphide Ores at Ducktown. W. H. Freeland. Describes work of the writer at Isabella, Tenn. The ore is a pyrrhotite, carrying less than 3 per cent. copper, and no precious values. The practice consisted in the smelting of raw ore to low grade matte, and the reconcentration of the low-grade, to a 50 per cent. matte. Ill. 1800 w. Eng & Min Jour—May 2, 1903. No. 55114.

Treatment of Lake Copper. J. B. Cooper. Read before the Lake Superior Min. Inst. A history of some of the difficulties experienced in the early efforts to smelt Lake ores and the final success. 2500 w. Mines & Min—May, 1903. No. 55061 C.

See also Mining and Metallurgy, Gold and Silver.

GOLD AND SILVER.

Alaska.

The Sea Level Mine, Alaska. W. H. Washburn. An illustrated article giving information in regard to this property. The pay ore is found mostly in gold-bearing pyrites in two white quartz veins. 2000 w. Min & Sci Pr—May 9, 1903. No. 55235.

Creede.

Creede Mining Camp. Prof. Arthur Lakes. Describes these valuable silver mines operated through the Nelson and Humphreys tunnels, and also the Humphreys mill. Ill. 2500 w. Mines & Min—May, 1903. No. 55052 C.

Cyanide.

The Regeneration of Working Cyanide Solutions, Where Zinc Precipitation is Used. Andrew F. Crosse. Describes the writer's process of regenerating cyanide solutions. 1700 w. Jour Chem & Met Soc of S Africa—March, 1903. No. 55-192 E.

Edison Dry Process.

The Edison Dry Process for the Separation of Gold from Gravel. A description of the process, authorized by Mr. Edison. Ill. 1200 w. Eng & Min Jour—May 9, 1903. No. 55145.

Gold Dredging.

Present Practice in Gold Dredging. R. H. Postlethwaite. Describes some of the newer devices which experience has shown to be advantageous. 2200 w. Mines & Min. May, 1903. No. 55060 C.

Mexico.

A Trip to Chihuahua, Old Mexico. Prof. Arthur Lakes. An illustrated description of the Descubidoro mine, with some impressions of the country, the people, and the mines. 2800 w. Mines & Min—May, 1903. No. 55057 C.

North America.

The Geological Features of the Gold Production of North America. Waldemar Lindgren. A collection of data regarding the product of each State, the derivation of the gold, showing the relative importance of different kinds of deposits, and the future outlook. 22800 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 55382 D.

Quartz Milling.

Notes on the Common Practice of Quartz Milling on the Rand. Fraser Alexander. A discussion of the methods most important in securing successful results. 3500 w. Jour Chem & Met Soc of S Africa—March, 1903. No. 55193 E.

Queensland.

The Etheridge Goldfield. (Q.) An illustrated article giving information of a much neglected field. 2500 w. Aust Min Stand—April 9, 1903. Serial. 1st part. No. 55264 B.

Riecken Process.

The Riecken Process for the Extraction of Gold (Les Nouveaux Procédés d'Extraction de l'Or. Procédé Riecken). F. Schiff. An illustrated description of this electrochemical cyanide process, used particularly in West Australia for sulphide and telluride gold ores. 1000 w. Génie Civil—April 11, 1903. No. 54890 D.

Separation.

The Separation of Gold from Copper, with Especial Reference to Pyritic Smelting. F. R. Carpenter. Read at the meeting of the Colorado Sci. Soc. An account of experiments, describing processes. 1600 w. Min Rept—May 7, 1903. No. 55132.

Silver-Lead.

Treatment of Oxidized Silver-lead Ores of Aspen, Colo. S. I. Hallett. Gives results of laboratory tests that look very promising and seem worth further experimenting. 1500 w. Min & Sci Pr—May 2, 1903. No. 55137.

Tailings.

Cyaniding Tailings in Sierra Co., Cal. H. R. Case. An account of treatment at the Young America quartz mine, near Sierra City. 1000 w. Min & Sci Pr—May 16, 1903. No. 55347.

IRON AND STEEL.

American Trade.

Some Economic Conditions Affecting the American Iron and Steel Trades. J. Stephen Jeans. Read before the Conference of the British Iron Trade Assn. Discusses the recent development of the output and capacity, the influence of the steel corporation, etc., in the present article. 2000 w. Ir & Coal Trds Rev—April 3, 1903. Serial. 1st part. No. 55151 A.

Analysis.

Standard Methods for Analyzing Iron. Outlines methods for separating and estimating carbon, phosphorus, and manganese. 13600 w. Jour Am Found Assn—May, 1903. No. 55374.

Standard Methods for Analyzing Iron. Herbert E. Field. A classification of the methods used in different laboratories, as collected by the Metallurgical Section of the Foundrymen's Assn. 5000 w. Jour Am Found Assn—2 parts, April & May, 1903. No. 55168.

Notes on the Ammonium Molybdate Precipitation for Phosphorus. J. William Beatty. Gives some results recently obtained in the laboratory of the Sweet Steel Co., Syracuse, N. Y. 800 w. Ir Age—May 28, 1903. No. 55504.

Armor-Plate.

The New Armor-Plate Mill at Creusot. Two-page plate, illustrations, and description of a recently constructed mill at the Creusot Works, which makes it possible to roll armor-plates, commercially, weighing from 60 to 65 tons. 2800 w. Engng—May 1, 1903. No. 55201 A.

Axles.

See Mechanical Engineering, Machine Works and Foundries.

Blast Furnaces.

A New Blast Furnace Top. Axel Sahlin. Read before the Iron and Steel Inst. An illustrated description of the Julian Kennedy furnace top and hoist, stating the assumptions on which the design is based, and the advantages claimed. 3500 w. Ir Age—May 14, 1903. No. 55186.

British Columbia.

The Bull River Iron Mines. C. Hungerford Pollen. An illustrated detailed description of this property with remarks on its profitable working. 1500 w. B C Min Rec—May, 1903. No. 55298 B.

Carnegie.

Andrew Carnegie: His Career and Work, his Methods, and his Achievements. J. Stephen Jeans. An outline of the development of the American iron industry and the Steel Corporation. Photographs of prominent men in this industry. 14000 w. Ir & Coal Trds Rev—May 8, 1903. No. 55333 A.

Cementation.

The Cementation of Iron (Sur la Cementation du Fer). Georges Charpy. An account of quantitative researches on the cementation of steel, with different carbonizing materials, in electric furnaces at definite temperatures. 600 w. Comptes Rendus—April 27, 1903. No. 54882 D.

Demand.

The Expanding Area of Demand for Iron and Steel. B. H. Thwaite. Calls attention to the use in architectural construction, tramway and autocar transit systems. 1200 w. Ir & Coal Trds Rev—May 1, 1903. No. 55208 A.

Europe.

The Recent Development of the European Iron Industry. Reviews the history of the industry in Germany, France, Sweden, and Norway, Russia, Belgium, Austria-Hungary, and Spain. Photographs of prominent men. 9000 w. Ir & Coal Trds Rev—May 8, 1903. No. 55334 A.

Flue Dust.

The Effect of Flue Dust upon the Thermal Efficiency of Hot-Blast Stoves. B. H. Thwaite. Investigation made to determine whether it is possible with a given heating capacity to raise the efficiency of the hot-blast stove and sustain it as near to that possessed by any well-designed recuperator of a gas-fired open-hearth furnace. 4300 w. Ir & Coal Trds Rev—May 8, 1903. No. 55331 A.

"Frozen" Furnaces.

A New Process for Removing "Frozen" Masses in Furnaces (Ein Neues Verfahren zum Schnellen Beseitigen von Ofenansätzen und Dergleichen und zum Beseitigen Hinderlicher Metallmassen). Dr. Weeren. A description of a process, due to Dr. Ernst Menne, for removing solidified masses of metal, slag, etc., from blast furnaces, etc., by burning and melting with oxygen and other gases. 2500 w. Stahl u Eisen—April 15, 1903. No. 55431 D.

The Menne Process for Removing Metallic Obstructions. Translated from *Stahl und Eisen*. Describes this process, the principle of which is to use the heat of combustion of the material which has to be removed. Gives examples of work carried out. 2000 w. Ir Age—May 21, 1903. No. 55289.

Great Britain.

The Iron-Working Districts of Great

Britain. The first of a series of articles on the present conditions and immediate outlook of the principal iron-making centers of the United Kingdom. Photographs of prominent men. 1500 w. Ir & Coal Trds Rev—May 8, 1903. Serial. 1st part. No. 55335 A.

Iron Reduction.

The Influence of Carbon, Carbonic Oxide and Carbonic Acid on Iron and Iron Oxides (Ueber die Einwirkung von Kohlenstoff, Kohlenoxyd und Kohlensäure auf das Eisen und seine Oxyde). E. Baur and A. Glaessner. An analytical-chemical investigation of the processes in the blast furnaces, and the reduction of the different oxides of iron. Diagrams. 3500 w. Stahl u Eisen—May 1, 1903. No. 55-434 D.

Krupp Works.

The Krupp Works at Essen. Day Allen Willey. The first of a series of illustrated articles describing these noted works in Germany. 1800 w. Sci Am Sup—May 9, 1903. Serial. 1st part. No. 55128.

Middlesbrough Works.

The Works and Operations of the North-Eastern Steel Company, Middlesbrough-on-Tees, England. An illustrated detailed description. 6500 w. Ir & Coal Trds Rev—May 15, 1903. No. 55371 A.

Open Hearth.

The Development of the Continuous Open-Hearth Process. Benjamin Talbot. Paper read before the Iron and Steel Inst., with discussion. On recent progress and results obtained at furnaces in Pennsylvania. 7200 w. Ir & Coal Trds Rev—May 8, 1903. No. 55327 A.

The Development of the Continuous Open Hearth Process. Benjamin Talbot. Read before the Iron and Steel Inst. A report of recent progress and results obtained in the continuous process of steel making, based on recent visits to Pittsburgh plants, and the Pencoyd plant. 5000 w. Ir Age—May 14, 1903. No. 55185.

The Refining of Cast Iron by the Talbot Process (Affinage de la Fonte par le Procédé Talbot). A description of an open-hearth steel-making plant at Frodingham, England, including an oscillating furnace on the Campbell system, with other modern improvements, and its method of operation. 3000 w. Génie Civil—March 21, 1903. No. 54884 D.

The Open-Hearth Process. Lieut.-Col. Leandro Cubillo. A study of the balance of the furnace, of the temperatures, and of the oxygen in the bath, etc. 3800 w. Ir & Coal Trds Rev—May 8, 1903. No. 55328 A.

Pig Iron.

The Quality of Pig Iron for Foundry Use as Shown by Fracture and Analysis. S. B. Patterson. Read before the New England Found. Assn. Considers those influences exerted by the ordinary elements to be found in pig iron which are generally accepted as established, and things affecting the quality of castings. 4700 w. Ir Age—May 21, 1903. No. 55288.

Rolling Mills.

The Construction and Operation of a Combined Roughing and Universal Rolling Mill (Ueber Bau und Betrieb einer Kombinierten Grob- und Universalstrasse). J. Hübers. An illustrated discussion of plans for trains of rolls for large blocks and smaller shapes, to be worked together or separately. 1500 w. Stahl u Eisen—May 1, 1903. No. 55433 D.

Slag Cement.

See Civil Engineering, Materials.

Steel Constitution.

The Constitution of Steel (L'Etat Actuel de Nos Connaissances sur la Constitution des Aciers au Carbone). Léon Guillet. A review of the constitution of steel, and the combinations of iron and carbon of which it is formed, illustrated by diagrams and micrographs. Serial. 2 parts. 5000 w. Génie Civil—April 4 and 11, 1903. No. 54888 each D.

Note on the Influence of the Rate of Cooling on the Structure of Steel. Albert Sauveur and H. C. Boynton. Gives a statement of interesting facts brought to light in the course of experiments at Harvard University. Ill. 2200 w. Trans Am Inst of Min Engrs—Feb., 1903. No. 55391.

The Influence of Sulphur and Manganese on Steel. J. O. Arnold and G. B. Waterhouse. A report of an examination, by micrographic analysis, of a series of heat-treated steels prepared by Mr. Brinell. 1000 w. Ir & Coal Trds Rev—May 8, 1903. No. 55332 A.

Tempering Theory.

The Theory of the Temper of Steel (Au Sujet de la Théorie de la Trempe de l'Acier). André Le Chatelier. A discussion of the theory of tempering, and of the internal state of steel in general. 700. Comptes Rendus—March 10, 1903. No. 54868 D.

MINING.

Deep Level.

The Deep Level Problem of the Witatersrand. Briefly discusses the best type of winding engines for this work, giving an illustrated description of the Whiting double-sheave winding engine, and discussing its advantages and disadvantages. 1600 w. Engr, Lond—April 24, 903. No. 55028 A.

Drilling.

Diamond Drilling. J. N. Justice. Abstract of paper read before the Inst. of Min. & Met. Illustrates and describes boring operations in West Africa to prove the continuity of the ore chutes in depth, and to obtain information as to the dip of the formation. 2300 w. Ir & Coal Trds Rev—April 24, 1903. No. 55022 A.

The Cost of Diamond Drill Borings in the Colorado River Valley and at St. Mary's Lake, Montana. A. P. Davis. Gives extract from report of John T. Whistler describing work and giving costs, with comparison and general remarks. 1300 w. Eng News—April 30, 1903. No. 55091.

Electric Haulage.

Third-Rail Tail-Rope Haulage System. L. L. Logan. An illustrated description of an arrangement adapted to handling a large tonnage in a difficult place. 1400 w. Mines & Min—May, 1903. No. 55062 C.

Flumes.

Flume Construction. W. C. Ralston. Read before the California Miners' Assn. An accurate account of costs of construction of a flume in Calaveras County, California, with descriptive notes. Ill. 600 w. Eng & Min Jour—May 23, 1903. No. 55351.

Gas Detection.

Detection of Small Percentages of Gas in Mine Air. J. T. Beard. Describes an attachment for safety lamps by which the presence of small amounts of gas is made visible. 2500 w. Mines & Min—May, 1903. No. 55059 C.

Roads.

Roads for Mines. James W. Abbott. Discusses the essential points in this branch of the engineer's practice. Location, grade, staking out the line, and details of construction are considered in the present article. Ill. 3000 w. Eng & Min Jour—May 16, 1903. Serial. 1st part. No. 55227.

Safety Explosives.

Experiments with Safety Explosives (Mitteilungen der Berggewerkschaftlichen Versuchsstrecke. Versuche mit Sicherheitssprengstoffen). Hr. Beyling. An account of experiments with various safety explosives for coal mines, undertaken at the mining companies' testing plant at Gelsenkirchen, Germany. 3500 w. Glückauf—May 9, 1903. No. 55443 D.

Tailings Elevator.

Peck's Centrifugal Tailings Elevator. F. Danvers Power. Illustrated description of a new tailings elevator designed to supersede the heavy and costly ladder type used on gold dredges. States the advantages claimed. 1000 w. Eng & Min Jour—May 23, 1903. No. 55350.

Timbering.

Systematic Timbering in Continental Mines. The present article illustrates and describes methods used in the north of France and Belgium. 2000 w. Col Guard—April 24, 1903. Serial. 1st part. No. 55020 A.

Timbering in the Collieries of Saxony and Austria. Illustrates and describes methods as reported by the Prussian Commission on "Falls of Roofs in Mines." 1500 w. Ir & Coal Trds Rev—May 1, 1903. No. 55209 A.

MISCELLANY.

Alaska.

Mineral Resources of Southeastern Alaska. William M. Brewer. Information relating to the Ketchikan mining district. The ores carry variable values in gold, silver, copper, etc. 1800 w. Min & Sci Pr—May 16, 1903. No. 55346.

Australia.

The Australian Mining Industry. J. L. C. Rae. Extracts from the presidential address delivered to the members of the Engng. Assn. of N. S. W. 2400 w. Aust Min Stand—March 26, 1903. Serial. 1st part. No. 55263 B.

Canada vs. U. S.

Mineral Production, Canada and United States. George Johnson. A comparison of the development of the two countries, based on the statistics for 1901. 2800 w. Can Min Rev—April 30, 1903. No. 55034 B.

Canadian Rockies.

Mining Possibilities of the Canadian Rockies. Bernard MacDonald. Discusses the possibilities of this region in regard to the mining and production of the precious metals, suggesting method for their exploration. Maps. 7000 w. Can Min Rev—April 30, 1903. No. 55032 B.

Electric Prospecting.

See Electrical Engineering, Miscellany.

Granite.

See Civil Engineering, Materials.

Helicoidal Wire.

Stone Cutting with the Helicoidal Wire (Le Sciage des Roches par le Fil Hélicoïdal). A brief illustrated description of this method of sawing rock and quarrying stone with a helicoidal steel wire. 000 w. Génie Civil—March 28, 1903. No. 54886 D.

Law.

The Latest Montana Mining Decision. Dr. R. W. Raymond. Discusses the change in the Supreme Court's decision in the Pennsylvania case, giving the portion covering the modification. 4000 w. Eng & Min Jour—May 9, 1903. No. 55142.

Manganese.

Manganese in the Upper Black Forest,

Baden (Die Manganerz-Vorkommen im Oberen Schwarzwald, Grossherzogthum Baden). Josef Lowag. A description of occurrences of manganese ore and the general geological formation of this region in Germany. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 14, 1903. No. 55480 D.

Mexico.

The Geographical and Geological Distribution of the Mineral Deposits of Mexico. José G. Aguilera. Discusses the minerals separately, locating the principal deposits. 9500 w. Trans Am Inst of Min Engrs—Nov., 1901. No. 55392 C.

Miner's Phthisis.

Miners' Phthisis. Discussion of paper by William Cullen. 900 w. Jour Chem & Met Soc of S Africa—March, 1903. No. 55194 E.

Newfoundland.

Mining in Newfoundland. J. P. Howley. From the annual report to the Minister of Agriculture and Mines. 2000 w. Can Min Rev—April 30, 1903. No. 55-035 B.

Nickel-Copper.

A Process for Separating Copper and Nickel from Magnetic Gravels (Verfahren zur Gewinnung von Kupfer und Nickel aus Kupfer und Nickelhaltigen Magnetkiesen). E. Günther. An abstract of an inaugural dissertation on an electrolytic process for extracting nickel and copper separately after metallurgical treatment of the ore. 5000 w. Zeitschr d Ver Deutscher Ing—April 18, 1903. No. 55446 D.

Nickel Steel.

Researches in Nickel Steel (Recherches sur les Aciers au Nickel). Léon Guillet. A micrographic and mechanical study of nickel steel and its properties, with micrographs, diagrams and tables. Serial. 3 parts. 9000 w. Génie Civil—May 2, 9 and 16, 1903. No. 54897 each D.

Ore Deposits.

Ore-Deposits Near Igneous Contacts. Walter Harvey Weed. Deals with ore-deposits whose structural features or mineral contents result, directly or indirectly, from igneous intrusions and their after-effects. 12000 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 55393 C.

Some Practical Suggestions Concerning the Genesis of Ore Deposits. Max Boehmer. A study of the action of underground waters, their sourse of supply, etc. 2000 w. Trans Am Inst of Min Engrs—July, 1903. No. 55387.

Ore-Deposition and Vein-Enrichment by Ascending Hot Waters. Walter Harvey Weed. Gives conclusions from a study of the copper veins of Butte, Montana, and other deposits. 3000 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 55386.

The Secondary Enrichment of Ore Deposits. George Smith. Discussion of the paper of S. F. Emmons, presented at the Washington meeting, Feb., 1900. 1500 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 55388.

The Syncline as a Structural Type. T. A. Rickard. A consideration of this class of ore deposits. Ill. 1000 w. Eng & Min Jour—May 16, 1903. No. 55228.

Petroleum.

California Petroleum and Its Use as Fuel. A. M. Hunt. Reviews the development, giving interesting report of output and the number of wells in operation, and discussing the effect upon the fuel situation on the Pacific Coast. Ill. 2700 w. Jour of Elec—May, 1903. No. 55505 C.

Petroleum in New Zealand. Henry A. Gordon. An outline of the efforts made to test the oil-fields, and the conclusions reached. 2000 w. N Z Mines Rec—March 16, 1903. No. 55129 B.

Petroleum from a Chemist's Standpoint. Edmond O'Neill. Briefly considers its origin, distribution, exploitation, properties and uses. 2700 w. Jour of Elec—May, 1903. No. 55506 C.

Quarries.

The Caledonian Granite Company's Quarries, Kippford, Near Dalbeattie. Illustrated description of these quarries in Scotland. 1800 w. Quarry—May 1, 1903. No. 55265 A.

Quarrying.

Quarrying in the United States (L'Exploitation des Carrières aux Etats-Unis). A. de Gennes. An illustrated account of methods of working marble and other quarries in the United States. 1 plate. 2500 w. Mem Soc Ing Civils de France—March, 1903. No. 55408 G.

Queensland.

Queensland Mining Industry. Report of the under-secretary of mines, Mr. A. R. Macdonald, reviewing the year 1902. Maps. 20000 w. Queens Gov Min Jour—March, 1903. No. 54999 B.

Roasting.

Some Notes on Roasting with McDougall Furnace. S. S. Sorensen. A report of the working of a set of eight McDougall calcining furnaces at the Highland Boy smelter, Utah, commending their simplicity, economy, and efficiency. Ill. 2500 w. Can Min Rev—April 30, 1903. No. 55033 B.

Salt Cars.

East Galician Salt Cars (Ostgalizischer Salztransportwagen). Eduard Windakiewicz. An illustrated description of hand cars which have been introduced in salt works to carry the salt in process of manufacture from one part of the works to another, thereby eliminating man transport. 1 plate. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 28, 1903. No. 55482 D.

Salt Works.

The Salt Works of Rosières-Varangéville, France (Die Saline Rosières-Varangéville). Victor Wenhart. A description of salt mines and works in the north of France. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 21, 1903. No. 55481 D.

Tasmania.

Tasmania Mining and Metallurgy. Donald Clark. The first of a series of articles describing the mining and metallurgical resources of Tasmania, and the development. Ill. 2300 w. Aust Min Stand—March 12, 1903. Serial. 1st part. No. 55122 B.

Turquoise.

The Burro Mountain Turquoise District. George D. Reid. An account of this district in New Mexico, the mines, quality of stones, value, etc. 1500 w. Eng & Min Jour—May 23, 1903. No. 55352.

Zinc.

The Metallurgy of Zinc. Dr. J. Ohly. Discusses the furnaces employed at Joplin, Mo., describing a recent invention of Wm. C. Wetherill and discussing other improvements under consideration. 2300 w. Min Rept—May 14, 1903. No. 55250.

Electrolytic Zinc Extraction by the Hoepfner Process. E. Guenther. An illustrated account of this process, cost of plant and operation. 2500 w. Eng & Min Jour—May 16, 1903. No. 55229.

Zinc and Lead.

Zinc- and Lead-Deposits of Northern Arkansas. George I. Adams. Preliminary statement of results and conclusions based on a study of these deposits. 4800 w. Trans Am Inst of Min Engrs—Feb., 1903. No. 55390.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Accidents on French Railways in 1900 (Les Accidents sur les Chemins de Fer Français en 1900). Statistics of railway accidents in France, and also general railway statistics of the world. 1000 w. Rev Technique—April 25, 1903. No. 55423 D.

Government Accident Bulletin No. 6. Reviews the sixth quarterly bulletin of the Interstate Commerce Commission. The total number of casualties is 12,811. 3200 w. R R Gaz—May 8, 1903. No. 55124.

Train Accidents in the United States in April. Condensed record, with editorial notes on the most serious. 2500 w. R R Gaz—May 22, 1903. No. 55326.

MOTIVE POWER AND EQUIPMENT.

Brakes.

The Siemens System of Electrically Controlled Air Brakes (Elektrische Steuerung für Luftdruckbremsen. Siemens-Bremse). An illustrated description of an improved system in use on German railroads, by which the air-brakes can be operated electrically from any part of the train, and which possesses, besides, all the usual advantageous features of air brakes. 2500 w. Glasers Annalen—May 1, 1903. No. 55452 D.

A Study of Brakes (Etude sur les Freins). E. Billy and H. Noalhat. A discussion of shoe brakes for cars and other vehicles, from both theoretical and practical standpoints. Serial. Part I. 3500 w. Rev Tech—April 25, 1903. No. 55421 D.

See also Street and Electric Railways.

Brake-Shoes.

The Structure and Service of Modern Brake-Shoes. F. W. Sargent. Considers the function of the brake-shoe, explaining the action of various shoes, the effect of heat on the different types, work, wear, etc. 4500 w. Pro Pacific Coast Ry Club—April 18, 1903. No. 55170.

Buffer.

Radial Spring Buffer Between Engine and Tender. Brief illustrated description of a design of the Phila., Wilmington, and Baltimore R. R. The locomotives equipped with it are intended to run upon curves of 70-foot radius. 500 w. Loc Engng—May, 1903. No. 55071 C.

Car Lighting.

See Gas Works Engineering.

Cars.

Increasing the Capacity of Cars (Die Bestrebungen auf Erhöhung der Tragfähigkeit von Güterwagen). Hr. Engel. A discussion of British reports on American transportation and comparisons of American, British and German cars, particularly for coal and other heavy freight. Illustrations. 6 plates. 6000 w. Glückauf—May 2, 1903. No. 55442 D.

Some New English and Continental Passenger Cars. Illustrations and brief descriptions of sleeping cars and dining cars. 800 w. R R Gaz—May 22, 1903. No. 55325.

Coal Shipping.

See Mining and Metallurgy, Coal and Coke.

Couplers.

Automatic Couplers on British Railways. T. A. Brockelbank. Discusses their use in other countries, the danger to employes in coupling cars, traffic delays, etc., urging the adoption of automatic couplers. General discussion. Ill. 9400 w. Jour Soc of Arts—May 1, 1903. No. 55187 A.

Automatic Coupling for Railway Cars (Attelage Automatique des Wagons). G. Mareschal. An illustrated description of an automatic coupling, invented by M. Boirault, which is being experimented with on French railways. 1000 w. Génie Civil—April 25, 1903. No. 54895 D.

Gasoline Vehicles.

See Mechanical Engineering, Automobiles.

Journal Box.

The Improved Symington Journal Box. Gives the causes of failure of journal boxes, and describes the improvements made in this design. Ill. 1000 w. R R Gaz—May 8, 1903. No. 55125.

Locomotive Efficiency.

Experiments on the Efficiency of Locomotives (Expériences sur le Rendement des Locomotives). Joseph Nadal. An illustrated account of tests on Franch railways to determine the performance and efficiency of locomotives of various types, with particular reference to the action of the steam in the cylinders. Tables and diagrams. 1 plate. 9000 w. Rev Gén des Chem de Fer—May, 1903. No. 55405 H.

To Make Compound Locomotives Efficient. W. A. Buckbee. Discusses various types and the need of a better understanding of the construction and operation of these engines in the service for which they are adapted. 1800 w. Loc Engng—May, 1902. No. 55070 C.

Locomotives.

British Locomotives in 1902. Charles Rous-Marten. Remarks on the general tendency, with illustrated descriptions of designs, and report of the performances that show progress. 5700 w. Bul Internat Ry Cong—April, 1903. No. 55379 E.

Compound Passenger Locomotives on the Eastern Railway of France. Charles S. Lake. An illustrated description of engines in use on the Chemins de Fer de l'Est. 1500 w. Prac Engr—May 15, 1903. Serial. 1st part. No. 55361 A.

Consolidation (2-8-0) Locomotives for the South Buffalo Railway. Illustrates and describes engines for handling heavy freight traffic over a hilly road. 800 w. R R Gaz—May 8, 1903. No. 55126.

Express Engine, Western Railway of France. Two-page plate, with description of four-cylinder compound locomotives used for express service. 2200 w. Engr, Lond. May 15, 1903. No. 55370 A.

Four-Cylinder Compound for the Jura-Simplon. Camille Barbey. Translated from the *Revue Generale des Chemins de Fer.* Illustrated detailed description. 700 w. R R Gaz—May 1, 1903. No. 55093.

Suburban Locomotive Development. An illustrated description of types, showing the development since 1860. 3000 w. R R Gaz—May 15, 1903. No. 55211.

Tandem Compounds for the New York Central. Illustration, cross sections, dimensions, and general information. 1100 w. Ry Age—May 15, 1903. No. 55252.

Tandem Compound Freight Locomotive. Illustrated description of the powerful locomotives of the 2-8-0 type, belonging to class known as G-4. 800 w. Am Engr & R R Jour—May, 1903. No. 55-074 C.

Tank Engine, London and Brighton Railway. Illustration and leading dimensions of a very powerful engine. 250 w. Engr, Lond—May 1, 1903. No. 55205 A.

Ten-Wheeled Locomotive for the Letterkenny and Burtonport Railway. Two-page plate with brief description of one of four recently built locomotives. 400 w. Engng—April 24, 1903. No. 55026 A.

The Great Eastern Railway "Decapod." James Holden. Introductory remarks on the needs of British railways, with illustrated description of this powerful engine and its operation. 2000 w. Cassier's Mag —May, 1903. No. 55180 B.

Logging Locomotives.

Logging Locomotives. Illustrations of a novel design used in Canada, with brief description. 700 w. Engng—May 8, 1903. No. 55282 A.

Motor Coaches.

Motor Coaches for British Railroads. Illustration and brief description of a steam motor coach built for the London and South-Western Railway. 1200 w. Sci Am—May 23, 1903. No. 55313.

Seamless Wheel.

The Ehrhardt Seamless Car Wheel (Nahtloses Speichenrad, Patent Ehrhardt). An illustrated description of a spoke wheel for railway cars in which the hub and spokes are forged from a single block of steel. 900 w. Stahl u Eisen—April 15, 1903. No. 55432 D.

Slipping.

Slipping of Locomotives at High Speeds. C. E. Wolff. A study of the conditions under which slip takes place, giving results of tests and conclusions. 800 w. Mech Engr—May 9, 1903. No. 55271 A.

Staybolts.

The Use of Steel Staybolts in Locomotive Fireboxes (Ueber Verwendung von Flusseisernen Stehbolzen zu den Feuerkisten der Lokomotiven). Hr. Meunnert.

An illustrated account of favorable experience with steel staybolts on German railways. 1000 w. Glasers Annalen—May 1, 1903. No. 55453 D.

Steel Cars.

Steel Cars on the Bessemer and Lake Erie Railroad. Drawings and information showing the development on this road. 2500 w. Am Engr & R R Jour—May, 1903. No. 55072 C.

Train Signals.

Permanent Communication Between Moving Trains (Intercommunication Permanente des Trains en Marche). Emile Dieudonné. Description of a system invented by Senor Basanta, by which moving trains are connected telephonically with each other and with the nearest stations, and by which the different cars of a train are in telephonic communication. 2500 w. Rev Tech—March 25, 1903. No. 55418 D.

NEW PROJECTS.

Africa.

New Railways in Southeast Africa. Sketch showing the routes of present lines and the approximate routes of authorized lines, with information relating to them. 500 w. U S Cons Repts, No. 1651—May 20, 1903. No. 55287 D.

Grand Trunk.

The Grand Trunk Pacific Railway. Map and information relating to a proposed transcontinental railway from Quebec to the Pacific Coast. 1300 w. Ry Age —May 22, 1903. No. 55341.

London.

Extension of Clapham Junction Station —London and South-Western Railway. Plans and description of an extensive engineering work in progress, which will provide eight running tracks and a loop line between the Junction and the terminal station at Waterloo. 1800 w. Engr, Lond —May 1, 1903. No. 55206 A.

Ohio.

Location and Construction of the Ohio Residency, Pittsburg, Carnegie & Western R. R. Describes interesting engineering features on the portion of this line lying within the state of Ohio, also the methods used, giving costs of certain kinds of work. 4400 w. Eng News—May 21, 1903. No. 55319.

Trans-Andine.

The Trans-Andine Railway. Gives a synopsis of the Trans-Andine Railway bill recently passed by the Chilean Congress. 1500 w. U S Cons Repts, No. 1636—May 2, 1903. No. 54997 D.

PERMANENT WAY AND BUILDINGS.

Rail-Concrete.

Rail-Concrete Masonry on the New York, Ontario and Western. Illustrations and brief description showing method of using concrete masonry built on a foundation of old rails. 400 w. R R Gaz—May 22, 1903. No. 55324.

Shops.

Railroad Repair Shop Design and Equipment. George A. Damon. Considers present tendencies in new and reconstructed shops, introducing a general discussion of shop problems. 15800 w. W Ry Club—April 21, 1903. No. 55257 C.

Signalling.

Automatic Block Signals—C. M. & St. P. Ry. W. H. Elliott. An illustrated description of a recent installation on 14 miles of double track between Savanna, Ill., and Green Island, Ia. 1800 w. Ry Age—May 1, 1903. No. 55043.

Colonel Yorke's Report on Signal Practice in America. Charles Hanell. A reply to the portion of this report bearing on automatic signals. 1400 w. Ry & Engng Rev—May 2, 1903. No. 55031.

See also Railway Engineering, Motive Power and Equipment.

Stations.

New Stations for the National of Mexico and the Chicago & Northwestern. Illustrates and describes these stations, located at Sioux City, Iowa, and Monterey, Mexico. 1100 w. R R Gaz—May 8, 1903. No. 55123.

Terminals.

St. Louis Terminals Up-to-Date. Jno. J. Baulch. A report showing the importance of this city as a railroad center, and giving information of interest. 5500 w. St Louis Ry Club—April 10, 1903. No. 55171.

Tie-Notching Machine.

See Mechanical Engineering, Machine Works and Foundries.

Tie Plugs.

Concerning Hardwood Plugs to Hold Spikes in Soft Wood Ties. Quotes views of C. P. Sandberg, the well known European consulting engineer on rails and railways, and gives editorial suggestion. 1000 w. Eng News—April 30, 1903. No. 55089.

Ties.

Metal Ties in Germany. Translated extract from *Das Eisenbahngleis* by A. Haarmann. Describes metal ties used on the Georgs-Marien-Hutten railroad. Ill. 600 w. R R Gaz—May 15, 1903. No. 55212.

TRAFFIC.

Rates.

Grain Rates Declared Too High Reviews the decision of the Interstate Commerce Commission holding that the advance made recently in freight rates on grain and grain products from the west to the Atlantic seaboard is not justified. 1400 w. R R Gaz—May 1, 1903. No. 55094.

MISCELLANY.

Accounts.

The Need of a Depreciation Fund in Railway Accounts. Charles H. Grinling. A discussion of British railway finance. Considers that, under the present financial practice, such parts of a railway and its equipment as are liable to wear out and need to be replaced are wrongly dealt with. 3300 w. Bankers' Mag, Lond—May, 1903. No. 55064 C.

Address.

Mr. John F. Wallace on Railroading. Extracts from a lecture delivered at Chicago. Reviews the growth of the present railway systems, the organization and operation. 3300 w. Ry & Engng Rev—May 23, 1903. No. 55344.

American Railways.

Railway Traffic. An editorial review of the "Report on a Visit to America," by Lieut.-Col. H. A. Yorke. Considers steam railroads, tramways, subways and elevated lines, and high-speed interurban railways. 4200 w. Builder—April 25, 1903. No. 54998 A.

Education.

The Higher Education of Railway Officials. Rev. Henry A. Stimson. A discussion of the special education needed by the men who have charge of railways in their larger relations. 2300 w. Ry Age—May 1, 1903. No. 55042.

Light Traffic.

Concerning Railways of Light Traffic. Editorial discussion of construction and operation costs, giving statistics compiled from the annual report of the Maine R. R. Commission for 1902. 4500 w. Eng News—April 30, 1903. No. 55090.

Track Foremen.

A Track Foreman's Qualifications. J. E. Conley. Part of a graduating thesis by a writer who has had years of railroad service. 3300 w. R R Gaz—May 1, 1903. No. 55095.

STREET AND ELECTRIC RAILWAYS

Address.

Electric Railways. H. M. Brinckerhoff. Abstract from a lecture before the night classes of the Lewis Institute as one of a series of semi-popular talks on engineering subjects. Ill. 4800 w. Jour W Soc of Engrs—April, 1903. No. 54992 D.

Appleyard Lines.

The Appleyard Syndicate's Interurban System. Map and illustrated description of an extensive electric railway system in Ohio, the lines in operation and proposed, their equipment, etc., with account of present business. 5400 w. St Ry Jour—May 16, 1903. Serial. 1st part. No. 55253 D.

Brake.

The Westinghouse Electromagnetic Brake (Frein Electromagnétique Westinghouse). M. Delas. A discussion of braking and an illustrated description of the Westinghouse-Newell brake for electric cars. 2500 w. Bull Soc Internat des Elect—April, 1903. No. 55413 H.

See also Railway Engineering, Motive Power and Equipment.

Cars.

Double-Deck Cars in Great Britain. Discusses the popularity of these cars in Great Britain, giving opinions of various authorities explanatory of their use there, after being generally discarded in America and on the Continent. 2300 w. St Ry Jour—May 2, 1903. No. 55097 D.

New Emergency Line Car. James H. Creedon. Illustrated description of a car embodying several new ideas which has recently been constructed for the Old Colony St. Ry. Co. in Massachusetts. 800 w. St Ry Rev—May 20, 1903. No. 55306 C.

Conduit Construction.

Conduit Construction in Brussels. Illustrated article showing the method of laying the conduit, which is laid on the side and forms one of the track rails. 1000 w. St Ry Jour—May 2, 1903. No. 55098 D.

Du Bois, Pa.

Improvements in the Du Bois Electric and Traction System. Illustrates and describes the improvements since the consolidation of the two companies controlling the electric interests. 3000 w. St Ry Jour—May 9, 1903. No. 55130 D.

Fenders.

New Automatic Fender and Wheel Guard. Illustrates and describes a fender of this type and its operation. The invention of W. T. Watson. 1100 w. Sci Am —May 30, 1903. No. 55522.

Freight.

The Carriage of Goods on Electric Tramways. Alfred H. Gibbings. Abstract of a paper before the Manchester Section of the Inst. of Elec. Engrs. The present article considers the existing methods and cost of conveying goods, and begins a discussion of proposed methods. 3000 w. Prac Engr—May 1, 1903. Serial. 1st part. No. 55210 A.

Huddersfield, Eng.

Huddersfield Corporation Tramways. An illustrated article describing the change from steam to electric traction. 3000 w. Tram & Ry Wld—April 9, 1903. No. 55017 B.

Italian Lakes.

Electric Railway from Milan to Gallarate and the Italian Lakes (Conditions d'Etablissement et d'Exploitation du Réseau Electrique de Milan à Gallarate et aux Lacs Italiens). M. de Marchena. An illustrated description of the construction and operation of this electric railway, generating stations and rolling stock. Triphase current is generated and then converted to direct current in rotary substations. 10000 w. Bull Soc Internat des Elect—April, 1903. No. 55412 H.

The Milan-Gallarate-Porte Ceresio Railway. An illustrated description of prominent features of a third-rail system, with high-tension transmission lines and rotary converter sub-stations. 1700 w. Elect'n, Lond—May 8, 1903. Serial. 1st part. No. 55275 A.

Load Diagrams.

Some Interesting Properties of Load Diagrams for Electric Railways (Ueber einige Interessante Eigenschaften des Belastungsdiagrammes Elektrischer Vollbahnen für Personenverkehr). Gustav W. Meyer. A discussion of passenger traffic and operation of electric railways, based on some load diagrams of the New York Elevated Railway. 3000 w. Zeitschr f Elektrotechnik—April 12, 1903. No. 55472 D.

London.

Electrification of the London County Council Tramways. An illustrated detailed description of the work of constructing this conduit system, with information relating to it, its electrical equipment, cars, stations, etc. 9000 w. Tram & Ry Wld—May 14, 1903. No. 55373 B.

The London County Council Electric Tramways. An illustrated description of the construction and equipment of the Westminster-Tooting section. 10000 w. Elec Rev, Lond—May 15, 1903. No. 55-367 A.

The London County Council Tramways. Gives a sketch of the general history and scope of the scheme, and an illustrated detailed description of the plant and equipment. A conduit line. 2200 w. Elect'n, Lond—April 24, 1903. Serial. 1st part. No. 55011 A.

The Hampton Court Line of the London United Tramways Company. Brief illustrated description of a branch line recently opened in England. 1200 w. Elect'n, Lond—April 24, 1903. No. 55-012 A.

London Underground.

The Electrically-Equipped Trains for the District Railway. Illustrates and describes the equipment and the systems of electrical control. 2500 w. Elect'n, Lond—April 24, 1903. Serial. 1st part. No. 55010 A.

The Whitechapel and Bow Railway. Illustrated description of a road representing modern British practice in the construction of a first-class double main line in cut and cover and in tunnel, or a shallow-tunnel subway. 1800 w. Engng—May 1, 1903. Serial. 1st part. No. 55200 A.

Los Angeles.

The Los Angeles and the Pacific Electric Railway System, Los Angeles, Cal. An illustrated description of the urban and interurban systems which have recently been consolidated by the Huntington-Hellman syndicate, and at present aggregate over 300 miles of track. 7500 w. St Ry Rev—May 20, 1903. Serial. 1st part. No. 55305 C.

Mersey, Eng.

The Electrification of the Mersey Railway. A brief account of the history of the original undertaking, with illustrated description of the change from steam to electric power. 5500 w. Engng—April 24, 1903. No. 55023 A.

The Electrification of the Mersey Railway. An illustrated description of the electrical equipment, with a comprehensive account of this important undertaking. It is the first steam line in England on which electric motors have displaced steam locomotives. 5000 w. Tram & Ry Wld—April 9, 1903. No. 55016 B.

New York Elevated.

The Electric Cars of the New York Elevated Railway (Die Wagen der New Yorker Hochbahn). S. G. Freund. An illustrated description of the cars of the New York Elevated Railway, which is operated on the multiple-unit system. 1200 w. Elektrotech Zeitschr—May 7, 1903. No. 55459 B.

Paris Metropolitan.

The Construction of the North Circular Section of the Paris Metropolitan Railway (Le Metropolitain de Paris. Construction de la Circulaire Nord). A. Dumas. A well illustrated description of the construction of this underground and elevated section of the line, principally of the elevated structure. 1 plate. 5000 w. Génie Civil—March 28, 1903. No. 54-885 D.

The Construction of the South Circular Section of the Paris Metropolitan Railway (Le Metropolitain de Paris. Construction de la Circulaire Sud. Viaduc sur la Seine à Passy). A. Dumas.

A well illustrated description of the construction of this section of the line, including the viaduct over the Seine, at Passy. 2 plates. 4500 w. Génie Civil—April 4, 1903. No. 54887 D.

The Courcelles-Ménilmontant Section of the Paris Metropolitan Railway (Le Métropolitain de Paris. Ligne du Boulevard de Courcelles à Ménilmontant). A. Dumas. A well illustrated description of this underground section of the line, through the heart of the city. 1 plate. 5000 w. Génie Civil—April 11, 1903. No. 54889 D.

Paris-Versailles.

The Electric Railway from Paris to Versailles. C. L. Durand. Brief illustrated description of the technical equipment and engineering features. 2700 w. Elec Rev, N. Y.—May 23, 1903. No. 55512.

Pavements.

Asphalt Pavement and Street Railway Tracks. W. Boardman Reed. An illustrated description of the tracks on Third Ave., N. Y., protected by the "Mullen Marginal Protecting Strip," with report of the wear. 1300 w. St Ry Jour—May 23, 1903. No. 55345 D.

Pavements Adjoining Rails. Daniel B. Luten. Notes the hard wear at this point, and recommends the use of brick to reinforce the asphalt at the rails. Ill. 1000 w. St Ry Rev—May 20, 1903. No. 55308 C.

Rails.

The Life of Tramway Rails. R. P. Wilson. Considers facts learned by experience in regard to prolonging the life of rails. Ill. 800 w. Tram & Ry Wld—April 9, 1903. No. 55019 B.

Rowan Steam Car.

Mechanical Traction of Tramways. Translated from *La Nature*. Illustrates and describes a Rowan steam motor car. 1700 w. Sci Am Sup—May 30, 1903. No. 55524.

Seattle-Tacoma.

The Seattle-Tacoma Interurban Railway. Howard S. Knowlton. Illustrated description of a high-speed electric railway on the third-rail system; the equipment, roadbed, track and right of way conform closely to steam railway practice. 6800 w. St Ry Jour—May 2, 1903. No. 55096 D.

Storage Battery Locomotive.

A Twenty-Ton Storage Battery Switching Engine. Describes a locomotive for shifting cars while loading or unloading, and for transferring material from one shop to another. 1200 w. Eng Rec—May 16, 1903. No. 55233.

Stray Currents.

See Electrical Engineering, Miscellany.

Surface-Contact.

Surface Contact Systems.—The Lorain System. Report by Mr. C. E. C. Shawfield, borough electrical tramway engineer to the Wolverhampton Corporation, on the surface contact tramways running in that town. Also brief notes on other systems. 6000 w. Elect'n, Lond—April 24, 1903. No. 55015 A.

Third Rail.

The Third Rail for High Speed Electric Service. Ernest Gonzenbach. Discusses interurban railways having a schedule speed of 20 miles per hour and above, considering construction details, and related matters. General discussion. 10600 w. Jour W Soc of Engrs—April, 1903. No. 54991 D.

Three-Wire.

The Grenoble-Chapareillan Tramway. Brief illustrated description of a three-wire system, with 1200 volts between the outers, installed in France. 600 w. Elect'n, Lond—April 24, 1903. No. 55-013 A.

Trunk Lines.

Electricity as a Motive Power on Trunk Lines. C. L. de Muralt. A paper claiming to show that it would be a great advantage both from an engineering and financial standpoint to have all trains propelled by electricity. A reply to the paper by Mr. Cornelius Vanderbilt. 3500 w. N Am Rev—May, 1903. No. 55153 D.

Tube Railways.

Tube Railways and the Law of Compensation. W. Valentine Ball. A discussion of British law as affecting these railways in the county of London. 4000 w. Trac & Trans—May, 1903. No. 55279 E.

Valtellina.

The Valtellina High-Voltage Polyphase Electric Railway (Die Valtellina-Hochspannungs-Drehstrom-Vollbahn). Eugen Cserháti. An illustrated description of this electric railway near Lake Como, Italy, on the Ganz tri-phase system, and its power station, rolling stock, and overhead construction. Serial. 2 Parts. 3500 w. Elektrotech Zeitschr—April 23 and 30, 1903. No. 55454 each B.

The Electric Equipment of the Valtellina Railway in Upper Italy (Elektrische Einrichtung der Valtellina-Bahn in Ober-Italien). Eugen Cserháti. A well illustrated description of this electric railway on the Ganz tri-phase system. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—March 27, 1903. No. 55479 B.

The Valtellina Railway. An account of the circumstances under which the project was carried out, with detailed description of the plant. Ill. 1500 w. Elect'n, Lond—April 24 and May 1, 1903. Serial. 2 parts. No. 55014 each A.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.

Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* Philadelphia.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Feilden's Magazine. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Straussenbahnen. *s-m.* Berlin.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Pacific Coast Miner. *w.* San Francisco.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* Chicago.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Electrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Copper.

The Copper Handbook. A Manual of the Copper Industry of the World. Vol. III. By Horace J. Stevens. Size, 9 by 6 in.; pp. 600. Price, $5 (buckram); $7.50 (full morocco). Houghton, Mich.: Horace J. Stevens.

The previous edition of this work was a most valuable compilation of information about copper, but it is fairly excelled by the present volume. The latter has been strengthened by the addition of a considerable number of new statistical tables, and former tables, reprinted and brought down to date, have been consolidated in all cases possible, thus affecting a considerable saving in space. These tables are believed to give the most comprehensive copper statistics ever prepared for any work. The chapters devoted to the scientific features of the copper industry have been entirely rewritten and greatly amplified, while a number of new chapters have been added, the part of the book devoted to the history and the technical side of the copper industry being about twice the length of the similar section in the last annual issue. The major part of the book contains descriptions of 2,207 copper mines and copper mining companies in all parts of the world. These have been made as detailed as warranted by importance and permitted by the material secured. There are eight chapters filled with descriptions of the copper deposits in all countries, and others devoted to copper history, geology, chemistry, mineralogy, metallurgy, uses and statistics, so that the book is a high-grade mine of copper facts, and more than maintains the standard set by its predecessors.

Motormen.

How to Become a Competent Motorman. By Virgil B. Livermore and James Williams. Size, 6 by 4 in.; pp. 232; illustrations and diagrams. Price, $1. New York: D. Van Nostrand Company.

The large electric railway companies find it advisable to maintain regular schools of instruction for motormen, and as a general rule, no man should be allowed to run an electric car without having had a thorough course of coaching. But he may get some serviceable knowledge from books, and it is the object of the present work to instruct motormen in the proper handling of the different equipments now being used by electric railways. There are descriptions of motors, brakes and other apparatus and their methods of operation, but the main part of the book is devoted to the controller, some of the leading types of which are shown by illustration and diagram. The arrangement of matter might be more systematic, and the diction is rather crude in places, but the book contains some good practical advice, is in convenient shape, and will no doubt be useful to the elecric railway man.

Tools.

Modern Machine Shop Tools. Their Construction, Operation, and Manipulation, including both Hand and Machine Tools. By William H. Van Dervoort, M. E. Size, 9¼ by 6 in.; pp. 552; figures, 672. Price, $4. New York: Norman W. Henley & Co.

In order to become a competent machinist, practical experience in the shop is absolutely necessary, but a very good general idea of the construction and operation of tools may be obtained from books, and by thus getting a systematic knowledge of machinery, the young apprentice can make much more rapid and orderly progress than if he relied merely upon what haphazard verbal instruction he could obtain. And if one desires to become anything more than a handicraftsman, the wider view obtained by study is essential. The present book will supply this knowledge, and give this broader view of the machine shop and the tools and appliances used therein. It is an outgrowth of a series of articles prepared by the author for the students in machine-shop practice at the University of Illinois, and is logically arranged, the various hand and machine tools being grouped into classes, and the description of each tool or machine being in accordance with its importance. It is a book of practical instruction. written with a full appreciation of the influence of modern manufacturing shop methods upon the training of young mechanics.

THE ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

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THE PROMOTION OF INDUSTRIAL EFFICIENCY AND NATIONAL PROSPERITY.

By John B. C. Kershaw.

III. THE FUTURE, AND TRADES-UNION HOSTILITY.

Mr. Kershaw's review of labour conditions, which began in our June number, is based primarily upon the situation in Great Britain, but for this very reason has the strongest interest for American readers—for unionism in America is patterning after unionism in England, and the situation in Britain today will be the situation in the United States a very short time hence. The rapid spread of the false philosophy of trades unionism in the States during the past few years is fast levelling down the industrial advantage they confessedly had but a little while ago. The vital need, therefore, is the enlightenment of the union leaders—the patient, conscientious effort of all concerned to dispel the fallacies by which labour has been so disastrously led in so many cases, and to establish true ideals of industrial economy for the guidance of employers and employees alike. It is for their value in this work that Mr. Kershaw's contributions have been welcomed to our pages.—THE EDITORS.

THE preceding article discussed the two chief causes of failure in relation to schemes of profit sharing in Great Britain in the past, and suggested a modified form of the American premium system of payment, in place of the usual bonus system of reward.

It is now necessary to consider the chief hindrance to the extension of the movement in the United Kingdom at the present date. This undoubtedly is the indifference, or active hostility, of the trades-union officials towards all forms of payment based on the results of individual effort.

In no case known to me has the movement received any welcome or support from these leaders of the workmen's cause. The reasons given for this attitude are four. It is asserted that firms who inaugurate schemes of this kind take the step for the express purpose of breaking up the unions, and thus diminishing the collective power of the men. The second objection is that premium systems and schemes of profit sharing are insidious forms of payment by results, and are based on no fixed principle. They are therefore in direct antagonism to the trades-union principle of fixed rates of payment for specific work, without regard to the final profits that may be earned by the firm or employer. It is further contended that these systems would lead to varying rates of remuneration for the same forms of work in different works or factories, since the premium, or share of the profits accruing to the workers, would be greater in the larger and better managed undertakings. These latter would thus have a command of the best workers, and further increase their advantage over their less successful competitors. Finally, it is urged that these systems lead to selfish indifference of the worker to the condition of his brother workers, and so far from being a step forwards, are a step backwards in industrial evolution.*

With regard to the first objection, there has certainly been some ground for the fear that profit sharing was a direct attack on unionism, since in one very notable instance, the scheme was inaugurated in order to "smash" the union; and in other cases, withdrawal of workers from membership in trades unions has been made a condition of participating in the benefits of the scheme. But there is no actual necessity that this should be the case, and in many of the instances in which profit sharing is in successful operation today, the employees are members of their respective trades-union organisations. The numerous conflicts which have occurred in the past between the unions and employers, upon the wages question, have however fostered the idea that the unions exist solely as fighting bodies. The extensive adoption of a plan which seems to settle the wages question upon a reasonable and just basis, is thus felt by trades-union leaders to threaten the continued existence of these organisations, which they regard (perhaps from rather mixed motives) as so essential to the maintenance of the worker's prosperity and progress. But is this idea of fighting bodies essential to the existence of trades-unions? The latter are simply bodies of men, engaged in the same or similar occupations, associated together for the purpose of protecting and furthering their corporate interests.† They differ from societies of professional men, as for instance of doctors, solicitors, chemists, merely in the status and educa-

* "Industrial Democracy," S. & B. Webb, Vol. II, pp. 549-558. "The Co-operative Movement," B. Potter, pp. 161-169.

† "Economics of Industry," Marshall, 1898, Chapter 13.

tion of their members. They can perform useful service, even if they never come into actual conflict with employers upon the wages question. Whatever may be the judgment as to the gains or losses of the struggles that have occurred in the past, there can be little doubt that in the face of the severe and growing competition which British manufacturers are now meeting in all parts of the world, trades unions will in the future best serve the interests of their members by utilising their forces in the promotion, not of industrial war, but of industrial peace.

The bonus and premium systems of payment offer distinct advantages for the peaceful settlement of the wages question in all large industries, if based, as I agree they should be based, upon trades-union rates of wages, and if a definite percentage of the surplus profits be set aside each year as the bonus fund. There are many directions in which the trades-union organisations could give useful help and information in this peaceful development of future years. By the collection and publication of statistics and laws relating to labour in other countries, notably those of their chief industrial competitors, they might educate their members to broader and sounder views upon industrial affairs, and promote that levelling up of labour conditions in eastern countries which will lessen the burden of competition, and remove the danger of retrogression in the workers' standard of comfort in their own. By the collection and publication of scientific and technical notes upon the industries or handicrafts in which the workers are engaged, they can increase the knowledge of their members and render them more efficient parts of the industrial organism. I know one instance only, in which a workers' union has commenced this kind of work. Why are there not more?

An important step in this direction by one of the largest and most powerful unions in the United Kingdom is however reported in the *Times* of June 21, 1902. A hall of residence for workingmen, called the Ruskin Hall, has recently been founded at Oxford, and money is urgently needed for the continuance of its work. The Amalgamated Society of Engineers have therefore promised to make a levy of one penny per member in aid of its funds. It is to be hoped that this promise may be fulfilled, and that it may be the forerunner of many similar attempts to interest the members of trades unions in social and educational movements for the benefit of the whole body of workers.

Should any satisfactory old-age pension scheme be launched in Great Britain, the trades unions, embracing as they do immense numbers of the wage-earning classes, might be of great service in the administration of the scheme, and in the collection of the contributions which might be required from the employees and workers in the various industries. It may prove impossible for the present Government to fulfill their election promises in regard to old-age pensions, but the trades unions officials, in conjunction with the employers, might be able to work out and administer a superannuation scheme for the benefit of the workers in particular industries, untilising for this purpose the invested portion of the bonus funds.

The trades-union organisations could therefore fulfill many useful purposes in the future, even should the extensive adoption of profit-sharing principles render wages disputes of rare occurrence; and it has undoubtedly been a mistake in the past for any of the employers to make withdrawal from the unions a condition of their workers' participation in the benefits of profit-sharing schemes. The stipulation is a wholly unnecessary one, and has hindered the progress of the movement by arousing the hostility of the union officials. These have felt that their extinction was threatened, and they have very naturally thrown all the weight of their influence against the adoption of schemes of this character,

With regard to the second and third objections to all forms of profit-sharing, urged by the trades-union leaders, it must be pointed out that the schemes are based upon payment of minimum fixed rates of wages for the different forms of work; and that in all the instances of which details have been given in the preceding articles these rates are the trades-union rates for the district in which the works or factory is situated. The premium, or share of the bonus fund apportioned to each individual worker, is thus an *addition* to the trades-union rates of wages, and undoubtedly differs in different works and in successive years; but since there is a definite limit below which the wages cannot fall, these two objections lose much of their force. Systems of this kind are, in fact, simply minimum-wage systems, worked in conjunction with a bonus system; and the net result is that the worker receives trades-union rates of pay, *plus a sum of money* paid weekly or annually, the amount of which depends upon the surplus profits of the year's operations. The objection that no fixed principle underlies it would be removed if all firms adopted the basis of say 5 per cent. as the normal rate of interest for capital invested in industry, and divided the profits earned in excess of this rate of interest more equally between capital and labour. A fairer or more just system of payment cannot be conceived, and trades-unions officials in continuing to oppose its adoption will be guilty of grave disregard of the workers' interests.

The fourth objection, that these systems promote selfishness, is one which becomes of little weight if the participants retain their membership in the respective trades unions, and use their influence in widening the area of adoption of such schemes, and in promoting the usefulness of their own unions in accordance with the ideas already expressed.

The objections of the official trades unionists are thus seen to be based upon misapprehensions as to the effects of premium and bonus payments on themselves and the workers, and to some extent upon a mistaken view of the true functions of unionism.

If the labour leaders could be won over to a recognition of these facts and could be induced to give not only their sanction but also their active support to all schemes of this character, there is not the slightest doubt that the movement would rapidly spread, and that the twentieth century would be characterised by a startling improvement in the relationship between capital and labour in all manufacturing industries. The recent decision of the Amalgamated Society of Engineers to countenance premium systems of payment in the engineering industry is a hopeful augury for the future. Should the larger number of trades-union officials, however, persist in their present policy of indifference or active opposition, progress will be hindered, it is true, but it will not be absolutely checked. In the past the trades-union leaders have often obtained the support of the outside public, because it was seen that in their struggles with the employers justice was on their side. They cannot expect, nor have they any right to receive, such support in the future, if under a mistaken conception of their duty they fight against reforms which will improve the financial position of the working man, and at the same time strengthen the position of their country as a manufacturing nation.

In conclusion, it must be pointed out that premium and profit-sharing systems alone will not suffice to place the relations between capital and labour upon an entirely just and satisfactory foundation. To quote from an article by Mr. H. F. L. Orcutt upon "Machine-Shop Management," which appeared in the issue of The Engineering Magazine for June, 1899.

> "The factory and machine-shop hand is becoming the slave of the automatic machine and the model shop. No diversity in his labour, no development in his mind, no progress from his experience. This is the danger to American workers. Both continents are striving for the ascendancy in home and foreign markets, but we rarely find a manufacturer who realises that social economic problems exist. How keenly are

all bent on studying the machine, its design, its output, care, and development. How few take any thought for the care and development of the human machine, the most important of all factors in reducing the cost and improving the quality of the product. How many employers think of the condition of their work-people as often as they do of their truck horses, of their stokers as well as of their boilers; what manufacturer cares as much for the food of the milling hand as he does for the quality of the lubricant of the machine which the milling hand attends, or gives as much anxious thought for the longevity of the turner as for the lathe which the turner runs? Who would expect profitable returns from a machine quartered in the damp and stifling atmosphere in which thousands of our factory hands live?"

The physical and social conditions of the workers, both in the factory and outside of it in their homes, cannot be neglected in the competitive struggles of the future; and those manufacturers will be most successful who have the financial courage to combine a system of premium or bonus payment with the arrangements for physical and social comfort, common in the larger German establishments. It is not claimed that the general adoption of such a combination would at once remove all occasions for friction and differences between employers and employees, or that it would usher in an industrial millenium. But it would afford ground for settling one of the most fruitful sources of difference, namely the wages question, upon a perfectly fair and just basis. It would teach both the workers and those who benefit by their work—the directors and shareholders of limited liability companies—that their interests are not antagonistic, but common. It would lead to an enormous increase in the efficiency of labour, and would prove a step—a fairly long step—on the road that runs towards "Industrial Peace."

AN INTRODUCTION TO THE STUDY OF ALLOYS.

By Henry M. Howe.

By special arrangement with Professor Howe, made at about the time he first entered upon the work of writing his great treatise on alloys which is shortly to appear in book form, and with the co-operation of his publishers, Messrs. Sauveur & Whiting, The Engineering Magazine presents these papers selected and condensed from the forthcoming volume "Iron, Steel and Other Alloys."

The portions thus taken for advance publication are those which lend themselves most readily to magazine use for an audience vitally interested in the accurate knowledge of materials of construction, and in the elements of the science which gives that knowledge. For anything more than the outline permitted by these limitations, the student must be referred to the book. Of Professor Howe's foremost authority on the subject it is needless to say a word. It is internationally recognized. It is proper to say that on account of his present absence in travel the final proofs of the article which appears below have not had the advantage of his personal revision.—The Editors.

BESIDE the general interest which we have in understanding the constitution of alloys, as giving us an intelligent view of the matter in general, we have the special reason that a knowledge of the subject promises to be of the greatest pracical value in approaching the study of any given series of alloys, for instance to one seeking to learn what are the most valuable alloys of two given metals. The case reminds us of the calculus. If we have the formula of a given curve before us we can by means of the calculus discover where all the critical points of that curve will lie without going to the trouble of plotting it throughout. Somewhat so is it with the examination of the constitution of a series of alloys, say those of bismuth with tin, or antimony with copper. The constitution of such a series may be expected to vary from one end of the series to the other; but in passing thus from end to end of the series there may be important critical points, at which not only the constitution changes but the nature of that change itself changes abruptly. Such points may be called critical points for constitution. And, just as the calculus reveals to us the critical points of a curve of known formula, so it happens that these critical points for constitution may often be laid bare by means of a few easy experiments.

Now the importance of this lies in the fact that the critical points for constitution may be expected to be also critical points for the useful properties. If we seek ductility, we may expect to find a critical point for ductility in that part of the series where lies a critical point for constitution: there we may expect to find either a maximum or a minimum of ductility; and so with many other useful properties.

Thus it is that the methods which promise to reveal to us with relative ease the probable constitution of a series of alloys of any two metals, of learning where its critical points lie, and indeed whether it has any critical points, thereby promise to teach us where in that series we shall probably find those alloys the properties of which will differ markedly for better or for worse from those of the component metals; and indeed, whether or not we are likely to find any alloys in the series which do differ markedly in their physical properties from the component metals. The knowledge of the constitution of a series of alloys in short gives us a method of superior analysis of the problem of where to find in that series the most valuable alloys. These indications, of course, are not conclusive; indeed we have still far more to learn of their meaning than we yet know; but already they are of great value as in pointing out the part of the field most likely to be fruitful.

FIG. I. PEARLITE WITH FERRITE (SORBY).
The polygons are pearlite; the network is ferrite.

In inorganic matter we have three important classes of substances:

1.—Pure elements,

2.—Definite chemical compounds of those elements, and

3.—Solutions.

In the same way we recognize in our alloys three classes of ultimate constituents:

1.—Pure metals,

2.—Definite chemical compounds of those metals with each other, such as $AuAl_2$, antimonide of copper (Cu_8Sb_3?), and antimonide of tin (SnSb), and also to a smaller certain extent definite chemical compounds of metals with the relatively small quantities of certain metalloids, such as carbon and sulphur, present in some alloys. In this latter class of compounds the most important is the carbide Fe_3C found in steel, and commonly called "cementite,"

3.—What are now called solid solutions of metals in each other.

FIG. 2. MICRO-STRUCTURE OF A CRYSTALLINE ROCK.

Any given piece of an alloy may at the same time contain substances of each of the three classes. Here, as in so many other respects, the alloys remind us of the crystalline rocks, which they resemble in the general conditions of their formation. Crystalline rocks have cooled either like most of our alloys from a state of fusion, or at least from a temperature so high that the atoms present in the rock-mass have been free to arrange themselves, to combine to form definite compounds, and these compounds have been free to obey their crystalline laws. Under the microscope we find that our rocks consist of three classes of substances:

1.—Pure metals, such as native copper, native gold, etc., 2.—Definite chemical compounds, like feldspar, mica, quartz, hornblende, and

3.—Glass-like obsidians, in which the chemical elements are united, not in any definite ratio, but indeterminately.

FIG. 3. STRUCTURE OF SLOWLY COOLED METAL.

Just as the particles of these different substances, the feldspar and other minerals, often exist in such minute particles that they can be detected only under the microscope, so in most cases the components of our alloys are visible only under the microscope, and often only with very great magnification, which may sometimes have to reach a thousand diameters. Fig. 1 gives us an idea of a common type of structure among our alloys, and it will be seen that it is strikingly like that of the crystalline rocks shown in Fig. 2.

The resemblance between alloys and crystalline rocks does not stop here. Indeed, we find close analogies between our metals on one hand and our crystalline rocks on the other, both of which result from the gradual solidification of fused or semi-fused masses; and also between both of these classes of solids and those which, like ice, result from the solidification of aqueous solutions instead of fused masses. Let us notice some of these points of resemblance.

First, the columnar structure familiar to us in the Palisades of the Hudson, the Giant's Causeway, and like rock-masses, forming enormous columns, we find reproduced both in metals and in ice. The columns of the Palisades were formed during the slow cooling of the rock-mass which they form; and they stand upright, i. e., with their length at right angles with their upper surface, which was the cooling surface, the surface through which the heat escaped from them while they were cooling down and changing from a molten glass or obsidian to a solid rock. We find in slowly cooled metals this same columnar structure, with the columns standing at right angles with the cooling surface, i. e., with the outer surface, as is shown in Fig. 3; and in large blocks of ice, especially in the ingots of artificial ice which we see about the streets, we can often trace this columnar structure, with the columns at right angles with the cooling surface, i. e., with the sides of the ice-ingot.

Next we find in solidified ingots of steel a contraction-cavity called a "pipe" at the upper end of the axis of the ingot (Fig. 4); and you will generally see a similar pear-shaped cavity in the upper end of the ingots of artificial ice about the streets.

Next the beautiful specimens of minerals which adorn our mineralogical cabinets generally form in the cavities or "vugs" as they are called in the rocks; beautiful crystals of iron at times occur also in the cavities in our steel ingots (Fig. 5); and in the same way we will often find most beautiful minute crystals of ice in the pear-shaped pipe of our common ingots of artificial ice. Again, just as the crumpling of the rocks of the earth's crust produces what is known as a schistose structure, so we find such a structure in masses of iron when they have been crumpled in like manner.

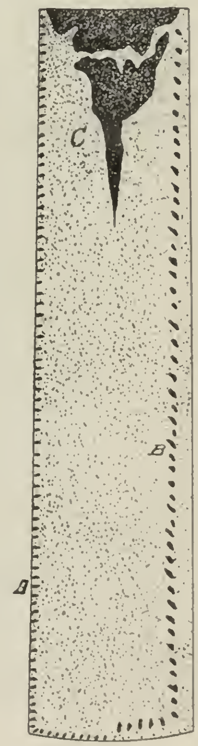


FIG. 4. PIPE AND BLOWHOLES IN AN INGOT.

Finally, gases evolved during solidification cause gas-bubbles or '"blowholes" in ingots of ice and of steel, and also in glass (*A* and *B*, Fig. 4). These blowholes form at a time when the mass is still fluid enough to be pushed aside by the particles of gas evolved within it, so that these come together to form gas-bubbles; yet not fluid enough to permit these bubbles to rise by gravity to the upper surface and thus escape. So these bubbles remain entangled in the viscous mass.

While the condition of the particles of pure metals which we find in our alloys calls for no special comment here, that of the chemical compounds and of the solid solutions requires a word.

The chemical compounds of one metal with another do not in general follow the law of valence, so that they are of the type known as "molecular." The law of valence retains its importance, but we must recognize

STEEL CRYSTAL, A LITTLE LESS THAN ONE-HALF NATURAL SIZE. COLLECTION OF PROF. TSCHERNOFF.

that it is not a universal one. And it is in accordance with this general idea that even the definite chemical compounds of one metal with another, as of copper with antimony, or gold with aluminium, or tin with antimony, as they do not follow the law of valence, are feebly combined, and that their properties differ from those of their component metals in a very much less degree than is the case with the common strong chemical compounds with which we are familiar in inorganic chemistry. The properties of water are wholly different from those of hydrogen and oxygen; the properties of common salt give no suggestion of those of either chlorine or sodium. Naturally we find no such striking difference between the properties of a definite compound of aluminium with gold on one hand, and the properties of aluminium and of gold respectively in the other.

The term "solid solution" is used to distinguish these substances from solid definite chemical compounds. We mean by solid solutions those solids which are to definite solid chemical compounds, like salt, what liquid solutions, like salt water, are to liquid definite chemical compounds, like pure water itself. We mean solids which have the essential characteristics of solutions so far as solidity itself permits.

To understand this let us ask what are the essential properties which distinguish our common liquid solutions from definite chemical compounds. In a definite chemical compound we have two essential features, (1) complete and absolute merging of the components into a new and different substance, chlorine and sodium losing their identity absolutely and forming a wholly different substance, common salt; and (2) a mathematically fixed ratio between the two components. In the case of solution, while this fixed-ratio feature is lacking, we have this same complete merging of the two substances. In a solution of water and alcohol we can neither by the microscope nor by any other means detect either the water or the alcohol; they unite to form a new substance: neither gravity nor centrifugal force separates them; the light alcohol does not rise to the surface, nor does the heavier water sink. This complete merging of their components and the absence of fixed ratio between these components, then, are the two essential characteristics of our common liquid solutions.

As the chemical forces which hold the dissolved bodies together in the new substance, the solution, are relatively feeble, naturally the properties of the solution do not differ markedly from the mean of the properties of the two bodies dissolved in each other.

Turning to the solid state we find in our glasses a similar state of affairs, except that the glasses are solid while common solutions are liquid. The silica, lime and alkali of the glass are absolutely merged; neither the microscope nor any other means enables us to detect either silica or lime or alkali as a separate entity in the glass, so long as it remains a glass. Only when we destroy it, tearing it asunder by analysis, can we detect any of its components. We have then in the glass a chemical merging of the components; but it is in indefinite ratios. The percentage of silica or of lime can vary by infinitesimal gradations from specimen to specimen, and this variation is accompanied by corresponding progressive change in the physical properties. The change from specimen to specimen, then, both in composition and in properties, is *per gradum* whereas the changes from one definite chemical compound to another, from water to hydrogen peroxide for instance, are *per saltum*. The glasses then have these two essentials of solutions, the substances present are (1) completely merged, but (2) in indefinite proportions.

In the same way many of our metals, as it were, dissolve in each other, and we find them in the solidified state completely merged in each other, forming alloys which differ from specimen to specimen by infinitesimal gradations, and yet the component metals cannot be distinguished in the alloy by the microscope or by any other means. The separate individual existence of each has ceased. Here then we have the essential characteristics of solutions, viz., (1) complete merging of the components (2) in indeterminate proportions; and on this account we give to these substances the name "solid solutions."

And just as the properties of the liquid solution, its color, density, electric conductivity, etc., do not differ markedly from those of the mean of its components, so we find that the physical properties in general of those alloys which are solid solutions do not differ markedly from the mean of the properties of the metals which compose them.

Liquid solutions, as we know, are habitually homogeneous, because in the liquid state diffusion takes place with considerable rapidity, so that even if a solution is initially heterogeneous, diffusion tends to make it homogeneous. From the conditions under which they form, however, and from the slowness of diffusion in the solid state, we should expect solid solutions to be heterogeneous.

As the science of petrography was in an advanced stage when that of metallography, of the constitution and structure of metals, was in its infancy, we naturally ask why the methods so fully developed for petrography have not been applied to metallography.

We may say that the essential procedure in petrography is to recognize the minute or even microscopic crystalline grains in our rock-masses by examining them with the microscope and with the polariscope, and by finding that they have the same crystalline form, and the same effect on polarized light, as the large crystals of the same minerals with which we are already familiar in the form of our cabinet specimens. Having determined accurately the crystalline form of quartz and its effect on polarized light by the study of large-sized cabinet crystals, we are able to recognize minute or even microscopic crystals of quartz by finding that they have the same crystalline form and the same action on polarized light. Manifestly, this method is wholly inapplicable to metallography. In the first place there are very few metals and alloys of which we have cabinet specimens suitable for standards with which to compare the crystalline form or other properties of the microscopic crystals which we find in our alloys.

Moreover, the metals and their alloys are opaque, so that the polariscope is wholly inapplicable. The discovery of the X-rays may have given rise to the hope that by them we could meet the difficulty of the opacity of our metals; but reflection shows that this hope was vain. For in most cases the particles of the different components of our alloys are so exceedingly minute that any individual grain of crystal would occupy but an insignificant fraction of the thickness even of the thinnest possible section, so that any given X-ray, in passing through such a section, would pass not through one individual grain or crystal of a given component, but through many different superposed crystals of all the different components which were present. In this way the shape of each one would be completely obscured and eclipsed by that of the other, and the effect of any given particle upon the X-rays would be masked by the effect of the other crystals through which that same ray would pass. There are indeed a few cases in which the individual crystals are large enough to be thus outlined by the X-rays, but even in these cases the structure can be more readily detected by microscopic study of the surface after it has been properly prepared. Thus the X-ray method is without either present or prospective value.

The chief method actually used in metallography is to correlate the results of our examination (1) of the structure as revealed by the microscope, (2) of the physical properties of individual alloys, and (3) of the physical properties of series of alloys taken as a whole.

Many of our alloys, as has been already pointed out, have a granitic or porphyritic structure; that is to say, like a granite they are composed of distinct grains, each grain being some one distinct entity, and of a distinct mineral species; and the different grains are of two or more different species. In the case of common granite there are grains of three different mineral species, mica, quartz and feldspar, lying side by side; and any individual grain is of some one of these species.

Now, the composition of granite taken as a whole is indeterminate, in the sense that, if we take a series of different granites and determine their ultimate composition, we find that the percentage of silica or of lime varies by irregular gradations from one specimen to the next; and the percentage of these components might vary by infinitesimal gradations from one granite to the next.

So many of our alloys are granitic or porphyritic. They are found by the microscope to consist of grains or crystals of different definite substances. Each grain is of some one of these substances, and these different unlike grains lie side by side, like the mica, quartz and feldspar of a granite. The substances which compose these different grains in our granitic or porphyritic alloys may be (1) pure metals, or (2) definite chemical compounds of two or more metals with each other in rigidly fixed atomic proportions, such as aluminide of gold ($AuAl_2$), antimonide of copper (Cu_8Sb_3?) and antimonide of tin ($SnSb$), comparable with the chemical compounds with which we are familiar in common inorganic chemistry; or (3) definite chemical compounds of a metal with a metalloid, such as the iron carbide (Fe_3C) called *cementite*, which plays a very important part in the metallography of iron and steel; etc, etc. One aim of microscopic examination is to ascertain whether the alloy is of this porphyritic type and consists of different distinct crystals of definite chemical composition, or whether it is of the obsidian type consisting solely of a solid solution; or whether it contains both definite minerals and also solid solutions. The further aim is to distinguish the shape, size, and the properties both physical and chemical of these various components.

The first step in general is to polish the metallic mass so that a large field may be visible under high magnification. The second is to subject it to an attack, either chemical or mechanical, which will affect the different constituents in different ways, and thus enable us not only to distinguish one from another but also to determine the shape, habit, and properties of each. Of these methods five deserve mention here. Of these the first three are chemical, the fourth mechanical, and the fifth partly chemical and partly mechanical. They are as follows:

(a) *Simple attack* by some solvent such as nitric acid, iodine, or licorice, a method which we owe to Sorby. Such a method may dissolve away one component more than another, or color one component differently from another, or it may simply eat away the joints between adjacent grains of crystals, and thus disclose their shape when they are later examined under the microscope.

(b) *Weyl's Method*, which has received great development in the hands of Charpy, is to attack by means of a solvent under the influence of a very gentle electric current. Charpy uses as the two poles (1) the alloy which is under examination and (2) at times platinum and at times another alloy of a composition so nearly similar to the first that the electro-motive force shall be very feeble, and therefore that the attack shall be extremely gentle. This gentleness is needed in all our methods. The particles which we wish to recognize and identify are so extremely minute, and often so feebly held in place, that we must use the utmost gentleness, whether in dissolving or in mechanically separating one from the other, lest we remove mechanically those components which we seek to leave untouched.

(c) *Heat-Tinting*. The different constituents may be differently colored by gently heating the polished surface, so that the more oxidizable ones become covered with oxide tints. This method has been used by Guillemin, and later by Stead, with most valuable results.

(d) *Relief Polishing*. Beyond these we have the mechanical methods, of which Osmond's "relief-polishing" is very important. By prolonged very gentle polishing, the softer constituents of a conglomerate alloy are worn away, leaving the harder ones standing in relief.

(e) *Osmond's "attack-polishing"* combines the chemical and mechanical methods happily. He polishes the surface while it is exposed to a reagent which attacks or colors the different constituents differently, so that disintegration by the reagent and removal by the rubbing go hand in hand.

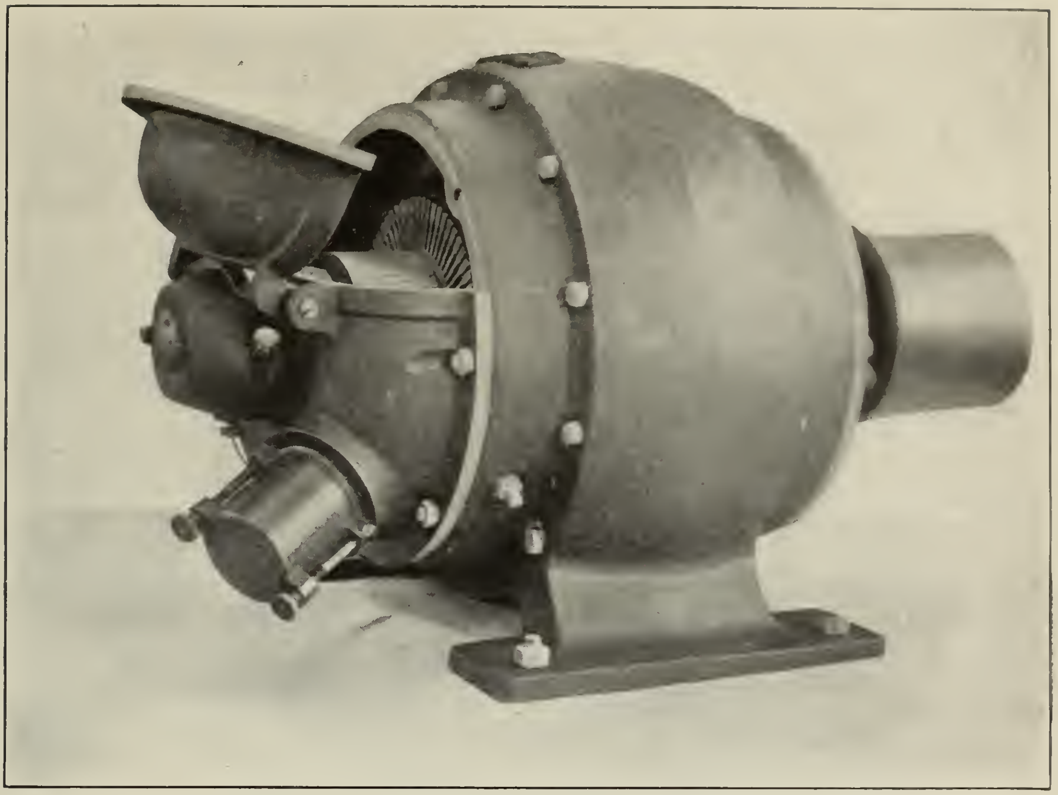


Fig. 1. 25-horse-power direct-current mine motor, Brioschi, Finzi & Co.

ELECTRIC POWER APPLIANCES IN THE MINES OF EUROPE.

By Emile Guarini.

There are, as M. Guarini points out, few departments of engineering in which electricity renders more efficient aid than it does in the operation of the mine. This general survey of the field from the viewpoint of Continental practice will be followed by a second article dealing specifically with the adaptation of motor driving to the larger power uses and the more important primary operations of mining.—The Editors.

THE substitution of mechanical power for human or animal labour is one of the most characteristic tendencies of our age, which indeed is marked by an almost feverish activity in this direction. This tendency is far more advanced in America than in the older Continent, but this is by no means saying that Europe is neglecting machinery in its adherence to manual labour. That would be ultra-conservatism. One could hardly conceive, at the present day, of a mine being pumped by hand, of the tramming and hoisting being done by manual effort solely, or of the stoping being carried on with no tools but hand drill and pick and no power but the arms of the miner.

Such a mine could not pay expenses. The manifest advantage of the use of power in the mine has led to the introduction of divers systems of transmission and application—by rods, by steam, by hydraulic pressure, by compressed air. But all these systems have disadvantages, some of them so great that the continuance of their use has been only for lack of something better.

Pump rods, with their huge dimensions and despairing slowness of movement, require an enormous expenditure of power; add to the loss of energy the high initial cost of the installation, and it is easy to see why they were abandoned as soon as possible for other systems more economical, though still not free from faults. Steam, water under pressure, and compressed air, all require piping, and this is their chief drawback. The pipes are difficult to install, to maintain, and to keep tight. Their length and the attendant friction and leakage losses diminish the efficiency. Added to that in the case of steam is the moist heat of the mine which affects injuriously the health of the workers and the condition of the timbering.

These serious disadvantages of the older methods explain the promptness with which the study of the application of electricity to mining was taken up as soon as its possibilities were realized, and the field was actively entered by many large electric companies, working in collaboration with machine and tool builders for the production of mining machinery specially adapted to electric driving—companies such, for example, as Siemens & Halske, the Allgemeine Elektricitäts Gesellschaft and Union Elektricitäts Gesellschaft, the Helios, Schückert & Co., and Ehrhardt & Sehner, in Germany; Ganz & Co. in Austria-Hungary; Westinghouse, the General Electric Co., and Johnson & Philips, in England and the United States; Brioschi & Finzi in Italy; Electricité & Hydraulique in Belgium; the Oerlikon Co. in Switzerland. And from this collaboration of electrical and mechanical engineering manufacturers and the care with which the complicated and delicate problems were worked out by them, has sprung the movement which has planted on the Continent many installations of electric mining machinery, by which the exploitation of mineral deposits has been made more certain, more economical, and more comfortable for the mine workers.

The rapid growth in the use of electricity is therefore explicable by its manifold and great advantages. Electric power is transmitted easily and with but small losses even into places where it would be impossible to haul the coal for running a steam engine. The conductors are readily placed and the energy losses in them are not large.

Motor-driven machinery is easy to operate, is of high efficiency, and runs with great reliability and with very little attention. The central power station may be placed in the most advantageous position for economical running. The motors do not consume any energy when the machines they serve are at rest, and demand little expenditure ot time or material for cleaning and lubrication. Finally, the total number of employees may be considerably reduced.

FIG. 2. HERMETICALLY SEALED MINING MOTOR. THE HELIOS COMPANY.

In progress in the application of electricity to mining the various countries of Europe are however by no means on an equality. Germany is far in the lead, and German manufactures predominate. Simens & Halske have so to speak invaded all markets for electric mining machinery. By skillful appeal, by the most scrupulous care given to the construction of their mining machinery and the reliability of the material turned out, they have gained this lead. Electric applications in the German mines are numbered by the hundreds, and the majority have been installed by Siemens & Halske; the remainder of the work has been divided among several companies, the Helios having put in half a score of installations, and Schükert, the Allgemeine, and the Union, ten or fifteen each.

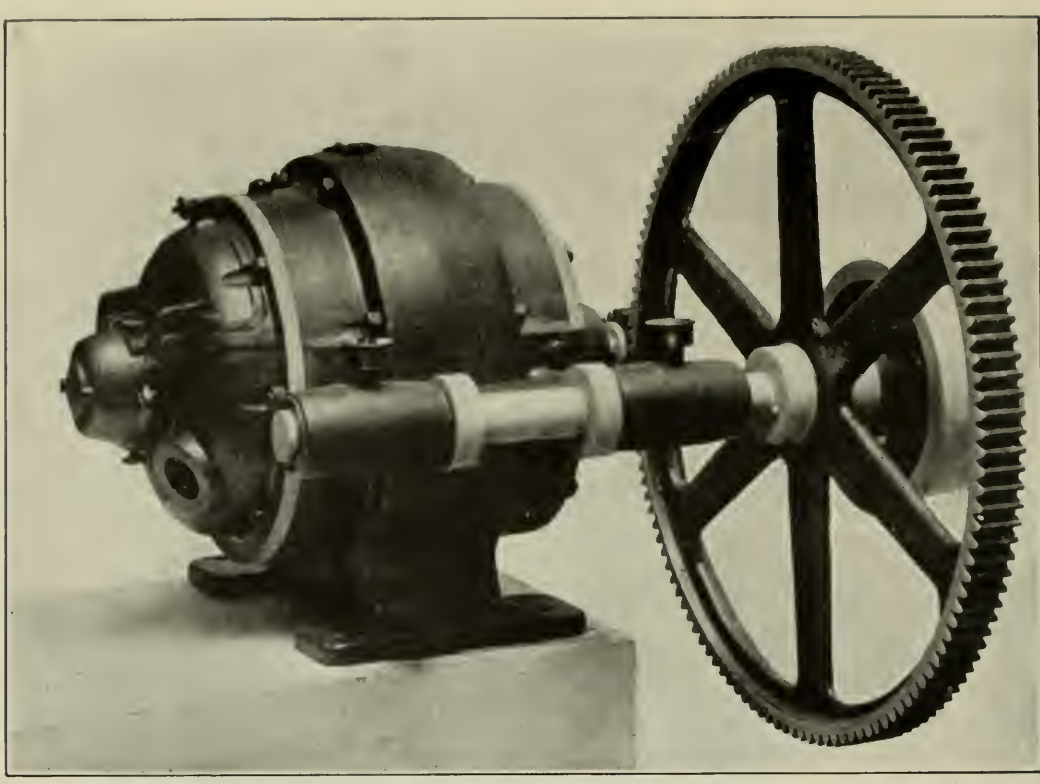


FIG. 3. GEARED MOTOR, BRIOSCHI, FINZI & CO.

In Austria-Hungary, a country rich in mineral deposits, the electric installations for mining work are almost as many as in Germany but in very few instances as important. Most of them are by Ganz, of Buda-Pesth, whose work at home and abroad comprises the equipment of some fifty electric mining plants.

England, with its many mines, would naturally be expected to show a large development of the use of electric appliances in mining. It does not, however, display the expansion in this direction one would anticipate. Most of the work of this character done by English firms has been for the South African gold mines. In Belgium also, though the mining industry is a large and important one, the use of electricity has only just begun to spread. Switzerland, a small country with but few mines, offers little opportunity; yet a Swiss firm—the Oerlikon—has put in some very important work in this line, if not at home at least abroad.

The other Continental countries are all dependent upon outside sources for their electric mining equipment. In Italy the little that has been done in this field has been done almost entirely by foreign houses. France owes her existing installations to the Thomson-Houston, the Oerlikon, and possibly a few other outside concerns. Spain has very little electric mining machinery, and that all from foreign sources of supply. The work in the Scandinavian countries has been done by German, or in some instances, English manufacturers; that in Russia, by German and Belgian firms.

While many Continental mines are electrically equipped, there is none, to my knowledge, which is operated throughout solely by electricity. Nevertheless every phase of work about the mine can advantageously make use of it—lighting, signalling, hoisting, drifting and stoping, ventilation, hauling and tramming, firing of shots, and the surface work and ore treatment. In all of these operations electricity is a valuable and economical auxiliary—valuable, because no other agency lends itself so well to the requirements of the mineral industry; economical, because the unavoidable losses are minimised and the means are very seldom wanting for the cheap generation of electric power at the mine. Use may be made, for instance, of a waterfall, even though several miles distant, or under other circumstances of waste gases from the furnace, or yet again, when these are lacking, of steam power. It may even be possible to use wind power, by putting up wind mills in sufficient number and of sufficient size (in Vienna they have been built of 25 horse power) with the necessary condition, of course, that some form of power storage be provided, either in the way of compressed-air reservoirs or of storage batteries. In short, the general introduction of electrically operated machinery can be nothing but advantageous to the mining industry, for electricity more than any other form of power fulfills the important requirements. Of these, the foremost is certainty of operation, for the interruption of the working of certain machinery—the mine pumps, for example—might endanger the entire mine and imperil the lives of the miners. Another matter of importance is strength and simplicity of construction of the machinery and ease of its control and management. In all these points electrical apparatus now excels.

In the choice of the type of motors to employ—whether direct- or alternating-current—both sides have their champions. The Allgemeine Elektricitäts Gesellschaft, the Union Elektricitäts Gesellschaft, and the Helios Company incline rather to the continuous-current, the Siemens & Halske and the English companies to the alternating-current type. There are good arguments on both sides. The partisans of the direct-current motor argue its smaller weight, the less number of wires (two or three, instead of three or four), the possibility of speed regulation—an important consideration in some cases, as for example in the hoists—and the fact that it permits the employment of storage batteries, either for power reserve or as buffer batteries. They urge as objection to the triphase motor the tension drop on starting; to the monophase, its slow speed, its small capacity for overload, and its low efficiency.

To this the advocates of the triphase system answer that the voltage drop is unimportant (from 580 to 540—say 40 volts) if the power at the generating station is increased at the time of starting the motor. They urge in its favor the simplicity and strength of the motors, their lack of delicate or complicated parts, and their independence of external conditions and of fouling, which is indeed an important consideration when a motor is installed in a damp, dirty mine gallery, full of steam, coal dust, or explosive gas.

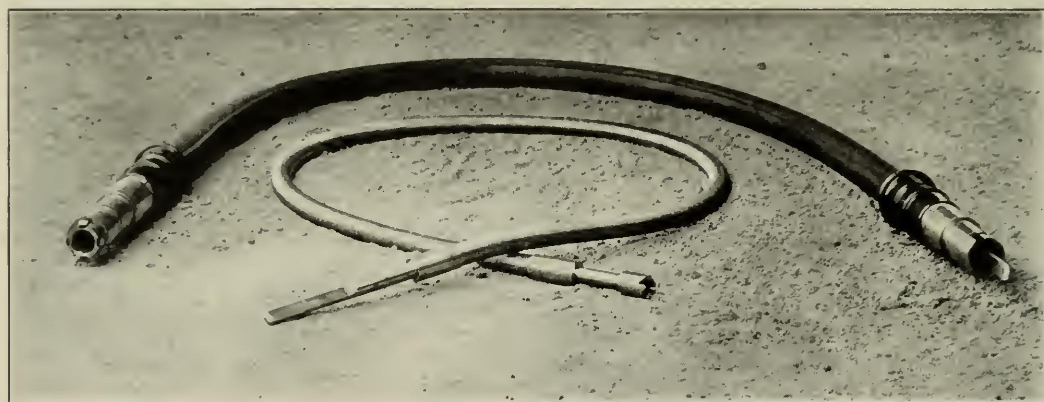


FIG. 4. FLEXIBLE SHAFT AND COVERING.

The decision depends finally on circumstances, and these circumstances, in mining, generally determine the case for the polyphase motor. The voltage of the direct current should not exceed 1,000 volts; ordinarily it is not more than 500 to 550; this is not economical for transmissions exceeding one kilometre. Alternating current, on the other hand, readily lends itself to the use of tensions as high as 10,000 volts, and at such tensions is transmitted without serious loss for distances of many kilometres. Further, it is easily stepped down to lower tension at the point of application. The advantage, in the main, therefore rests with the triphase system whenever the central generating station is far from the actual point of attack. The primary tension usually employed is 2,000 volts, the secondary or service tension being 500 volts.

To combine the advantages of both systems, certain firms—the Union Elektricitäts Gesellschaft, for example—strongly advise the combination of the alternating with the direct current, the former serving for the transmission from the central station and being transformed by a rotary into direct current at the mine.

The peculiar and very unfavourable conditions amid which a mining machine must work have compelled the development of special types of motors for this service. All the designers have sought to produce a motor—generally of the enclosed type—occupying very small space, unaffected by the surrounding asmosphere, non-sparking, non-heating even after 24 hours' continuous running, and easily taken apart and inspected. The Westinghouse Company even make a motor which, without being completely enclosed, is altogether non-sparking and runs with certainty when entirely submerged. Figure 1 shows a 25-horse-power 500-volt direct-current enclosed motor made by Brioschi, Finzi & Co. for a Sicilian mine. Figure 2 is a hermetically sealed motor for mining use made by the Helios Company.

A common difficulty in the use of electric motors for driving mining machinery is that their speed is not suited to the work in hand; the simplest, if not the best, means of overcoming it has been the use of gearing, as shown in Figure 3. The objections to this are the loss of efficiency, the space required, and the chance of breakage in the gearing, not serious, perhaps, with a small machine, but possibly a grave matter with a large one. For this reason preference is often given to belts. Sometimes the gearing is driven through a flexible shaft, like that shown in Figure 4, in which are seen the shaft and its covering. In place of these mechanical methods of speed reduction, electric means may be employed, either in the form of resistances or the application of counter electromotive force. Ordinarily the regulation is by a con-

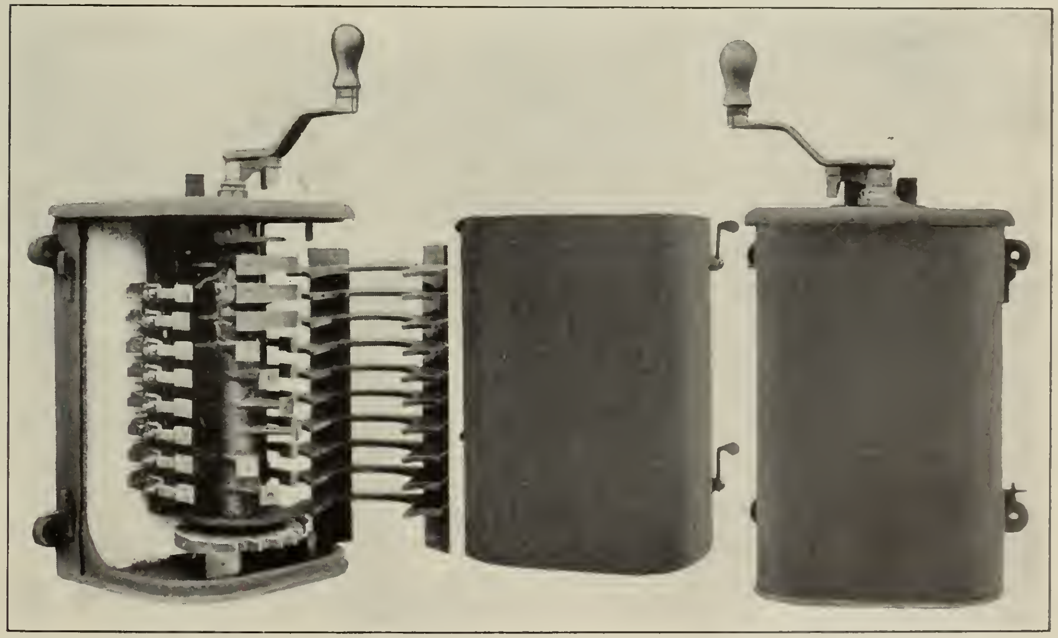


FIG. 5. CONTROLLER FOR MINE MOTOR. THE HELIOS COMPANY.

troller identical with those used with electric railway motors, as may be seen in the example by the Helios Company shown in Figure 5.

Where a motor must be moved from time to time, as for instance at the breast of an advancing gallery, the necessity of repeated lengthenings of the cables is avoided by the use of the arrangement shown in Figure 6; the cable is rolled on a reel, and uncoiled gradually as the advance of the motor requires. Continuous connection with the central station is thus maintained.

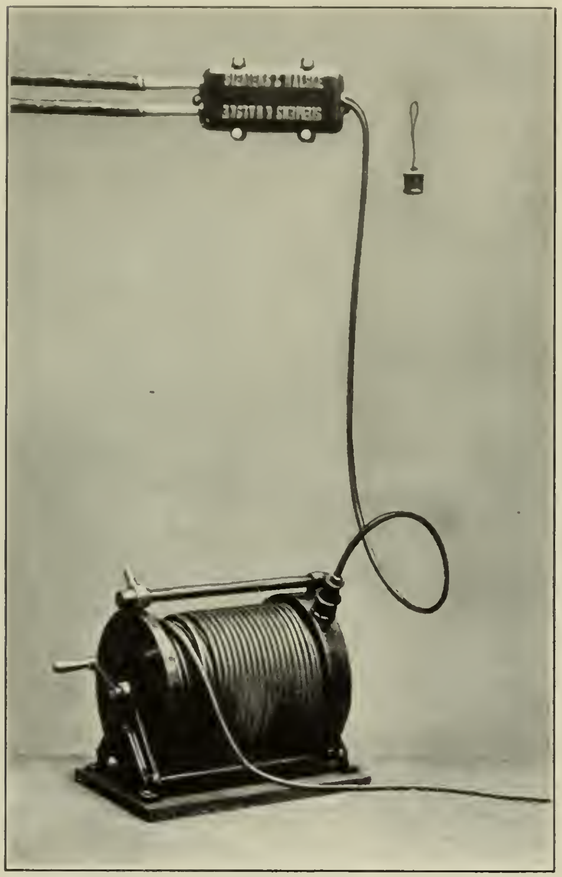


FIG. 6. CONDUCTING CABLE AND REEL.

The central power plant of a mining installation differs little from one designed for electric lighting or electric traction. Figures 7 and 8 show two interesting examples built by different electric companies. Figure 7 is the interior of the Union colliery at Zwickau, the installation having been made by Schückert & Co., of Nuremberg. There are two vertical steam engines of 700 horse power each, direct-coupled to two triphase alternators of 475 kilowatts at 2,100 volts. The engraving shows one of the main groups and the asynchronous motor driving the direct-current exciter.

In the electric power station of the Monterrad mine at Firminy, built and installed by the Oerlikon works, the prime mover is a horizontal steam engine of 300 horse power at 100 revolutions and a steam pressure of 103 pounds per square inch. This is connected to the dynamo by a Zoddel coupling. The generator furnishes triphase current at 1,000 volts, 20 periods per second. It has 24 poles; the diameter of the pole ring is 2.492 metres, and that of the interior of the armature 2.500 metres.

Figure 8 shows another type of installation, furnished to the Scharnhorst mines by the Helios Company, of Cologne. There are two alternators giving 300 kilowatts at 500 volts with 150 revolutions.

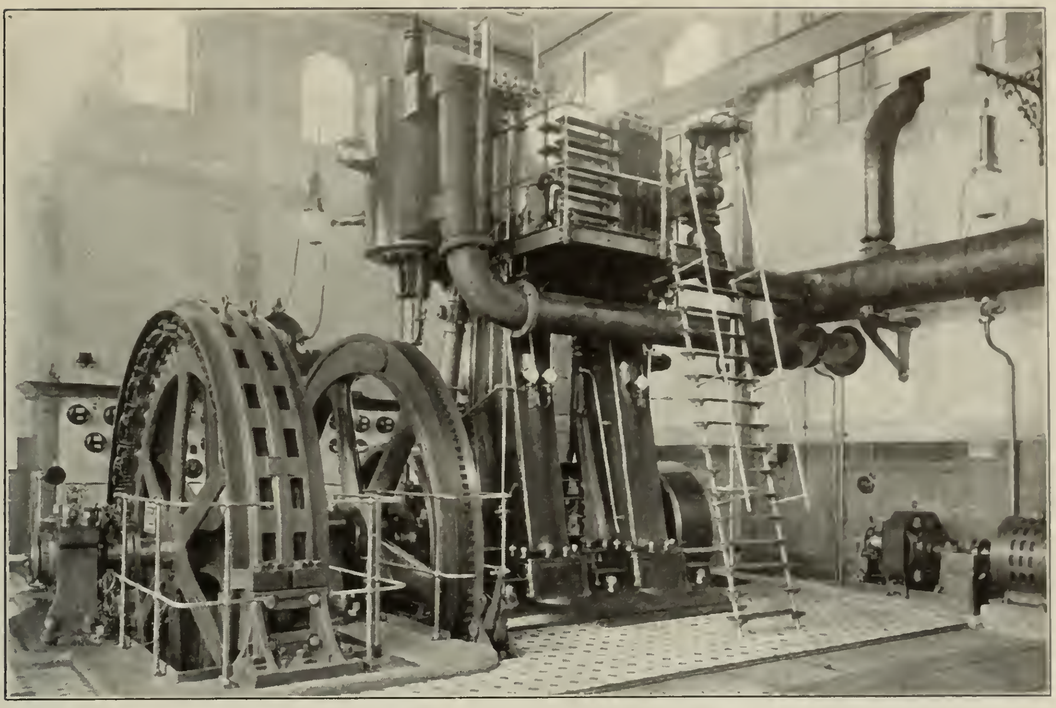


FIG. 7. POWER STATION OF THE UNION COLLIERY, ZWICKAU.

The distributing switchboard is usually placed in the central station, and where high-tension current is generated the high-tension connections are placed, for safety, on the back of the switchboard and quite out of the way of the low-tension apparatus. This arrangement is ex-

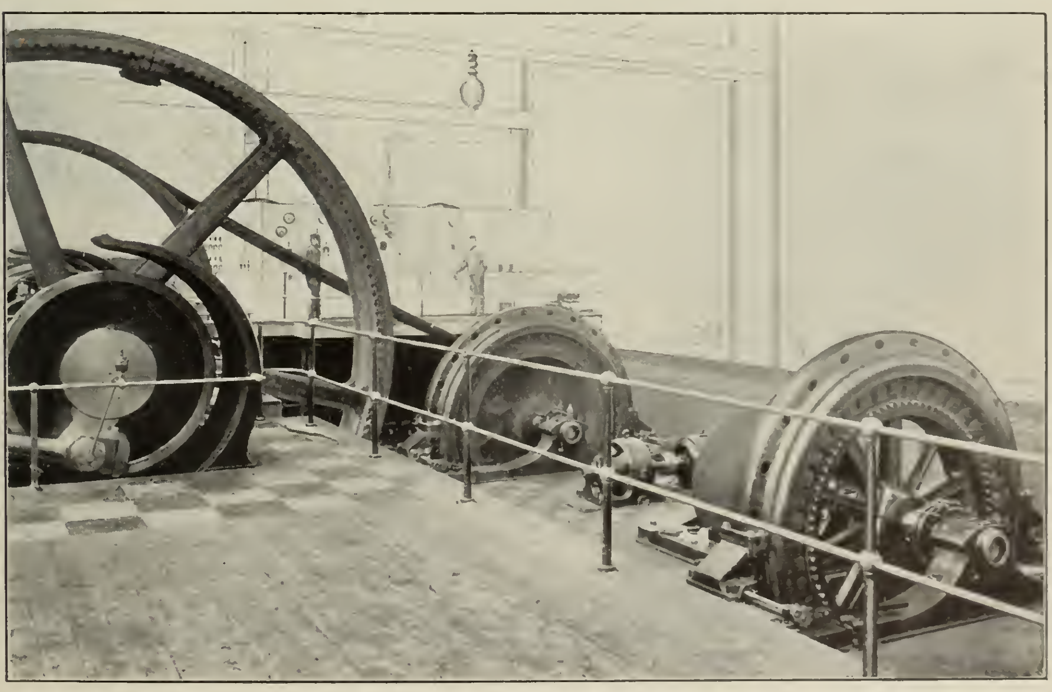


FIG. 8. POWER STATION, SCHARNHORST MINES.

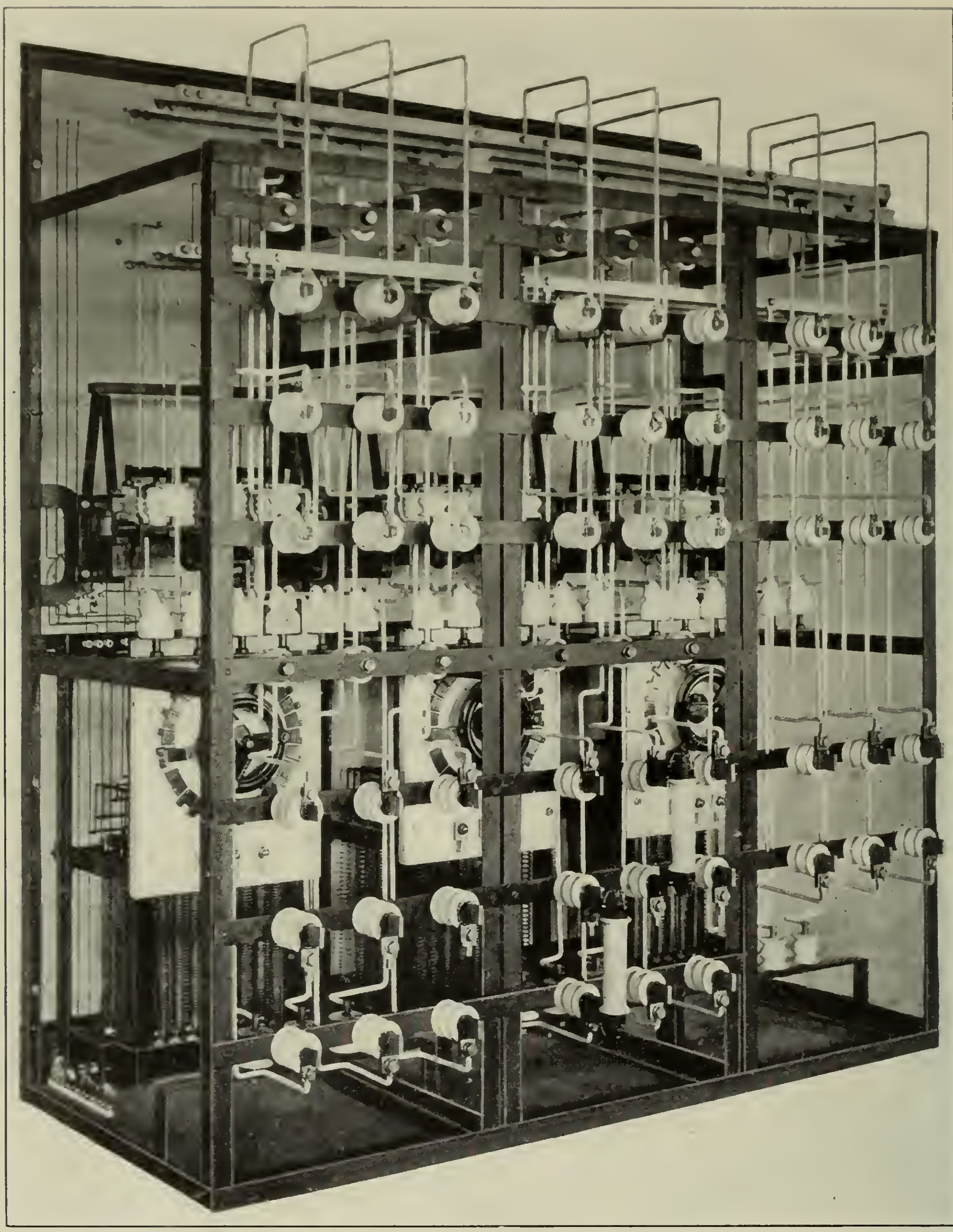


FIG. 9. BACK OF SWITCHBOARD INSTALLED BY THE HELIOS COMPANY AT THE GNEISENAU MINES.

hibited in Figure 9. It is arranged for three couples of dynamos and 2,400-volt current. The "distributing column" shown in Figure 10 is designed by the Helios Company to avoid the crowding and concealment of part of the apparatus which sometimes constitutes a disadvantage in the ordinary switchboard.

As in the case of the power plant, the lighting installation of a mine exhibits no special features. Arc lamps and incandescent lamps are both in use, the former particularly for the surface workings, as seen in Figure 11, which represents the headworks of a mine equipped by the Union Elektricitäts Gesellschaft. In other cases incandescent lights only are used, as in the Gottessegen mine at Zwick, where the Schückert Company installed 120 incandescent lamps on the surface and 30 in the underground workings. At the Beth mines of the Società Mineraria Italiana, the ore-treatment plant and the quarters in the valley of Chisone are lighted by continuous current at 110 volts supplied by the exciter dynamo; the buildings at the principal mine entrance, at an elevation of 2,700 metres, are lighted by triphase current stepped down from 2,000 volts to 210 volts. For the miners' portable lamps it is the practice to use storage batteries, on account of the difficulty which would be experienced in taking current from aerial conductors. In order to diminish the frequency of the necessary recharging, lamps of low wattage are preferably employed. The light is thus much less intense, and the consumption of current smaller.

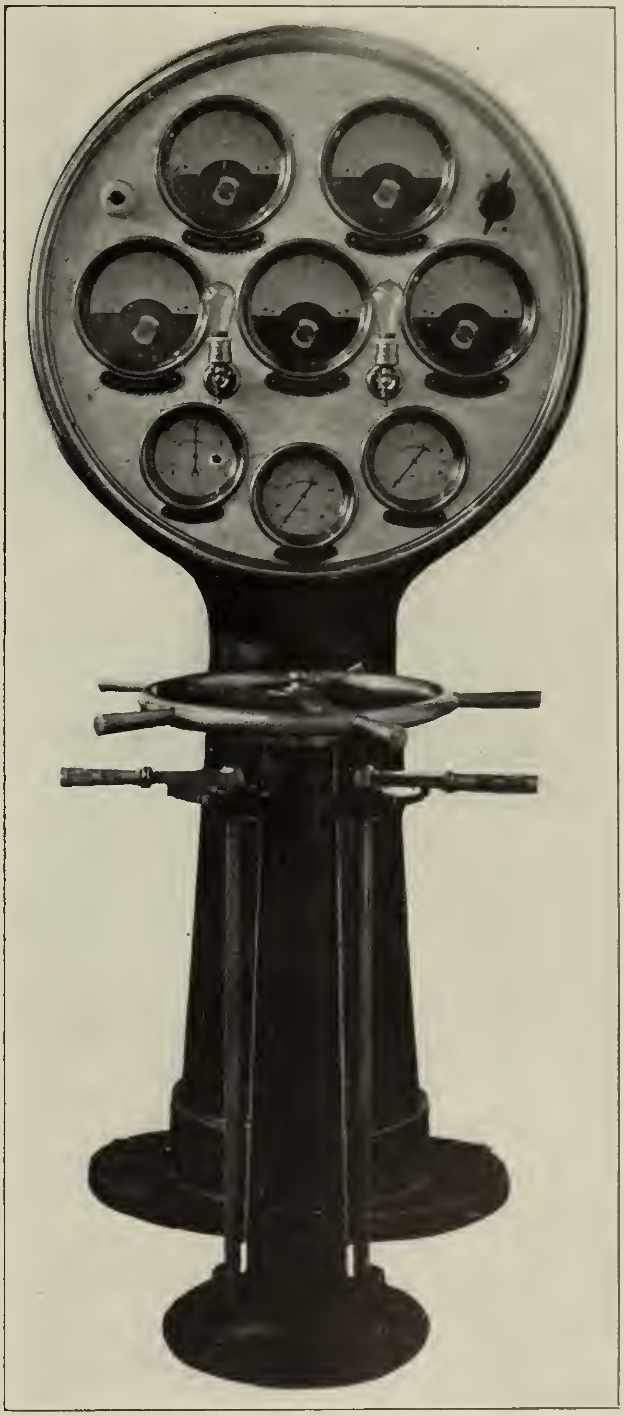


FIG. 10. SWITCHBOARD COLUMN.

If electric lighting of the mine and its adjuncts

FIG. 11. SURFACE PLANT LIGHTED BY ARC LAMPS.

FIG. 12. SIGNALLING SYSTEM, GLÜCKAUF MINE, SONDERSHAUSEN.

has received less attention than it merits, telegraphy and telephony as applied to this special service have received much attention from inventors. Three points especially have been subjects of study—certainty of operation, resistance to damp and to dust, and protection

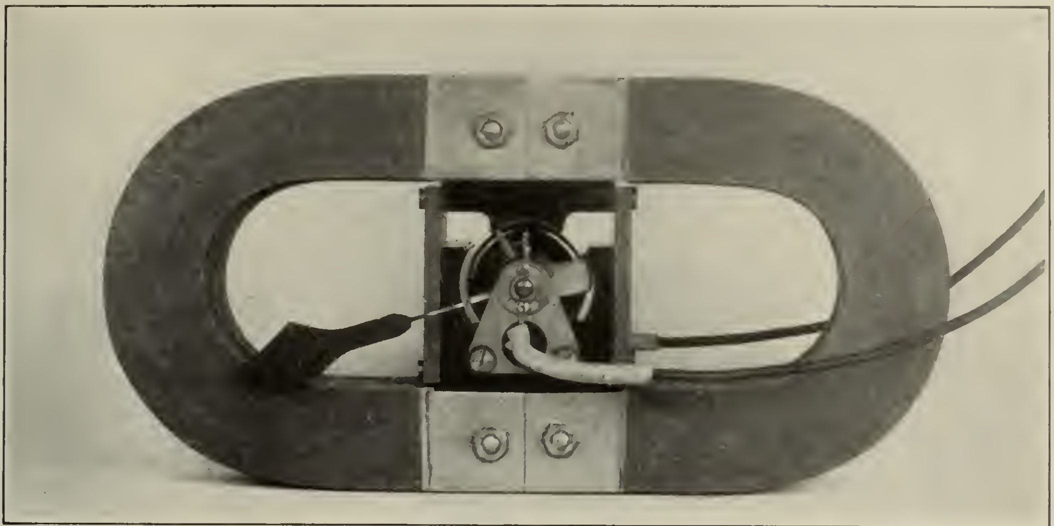


FIG. 13. MAGNETO RECEIVER FOR MINE SIGNALLING, UNION ELEKTRICITÄTS GESELLSCHAFT.

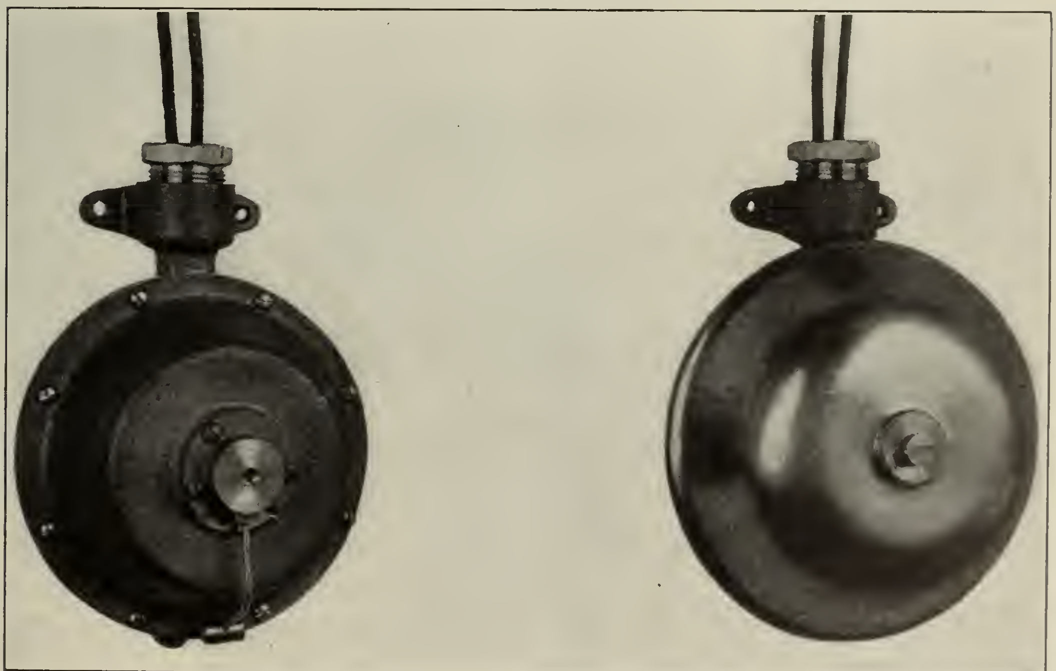


FIG. 14. ENCLOSED MINE CALL BELL.

from mechanical injury. Some manufacturers also have provided apparatus for currents of high intensity.

In the telegraphic systems, each station is usually provided with a transmitter and a receiver. The receiver commonly consists of a volt-

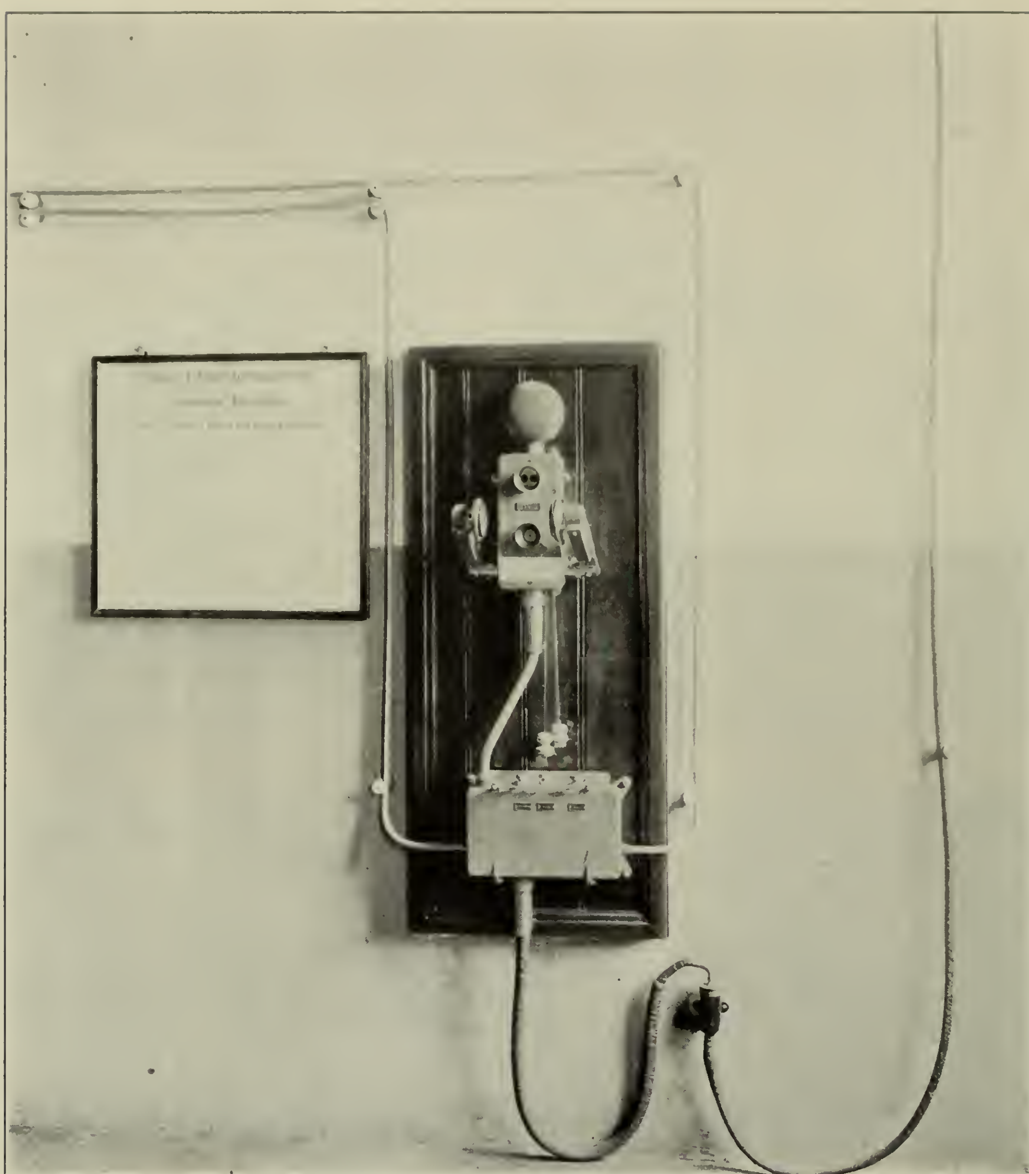


FIG. 15. SIEMENS & HALSKE MINE TELEPHONE.

meter around the dial of which are arranged a number of signals or orders. The operator transmitting the order turns the crank of a magneto machine until the needle of the transmitter dial reaches the signal desired. The same signal is indicated on the receiver dial, and usually is accompanied by as many strokes of the bell as the needle has advanced degrees. The operator receiving the signal repeats it back to the sender, who is thus assured that it has been correctly understood. Figure 13 shows the magnetic receiving system for mine signalling as installed by the Union Elektricitäts Gesellschaft. By virtues of a special form of the poles, the deviation is about 220 degrees. A small dial and a short needle permit the transmission of quite a large number of signals. Both transmitter and receiver, it is needless to say, are completely encased and impervious to dampness or dust. This is true also of the telephone apparatus, usually loud-speaking, the receivers and transmitters proper being customarily closed by rubber stops. When placed in very noisy situations, the telephones are usually provided with movable receiver tubes which the hearer turns forward and adjust to the ears. An installation of this type is shown in the illustration Fig. 15 on the opposite page. A series of push buttons serves to put the telephone in circuit with the various lines.

A great deal of the mine signalling may be done by simple sounders. Such is the case with the signalling connected with the mine haulage, to notify the operator at the winding engine or motor when a car has been hooked on, or if it is derailed, etc. For this service two bare wires are run from the signal bell at the hauling engine through the gallery where the trams run. A piece of metal of any sort serves to complete the circuit at any point. Mine call bells are operated by either direct or alternating current, and in the latter case they are often worked by magneto-electric machines identical with those used for the firing of blasts. They are built for currents from 6 to 110 volts. They are completely and hermetically enclosed, as shown in the example in Figure 14, representing a call bell made by the Union Elektricitäts Gesellschaft; on the left the bell is removed. Figure 12 is a signalling system put in by the Siemens & Halske Company in the Glückauf mine at Sondershausen. The view is taken at the bottom of the mine; at the back, to the right of the entrance to the shaft, is a closet containing a magneto

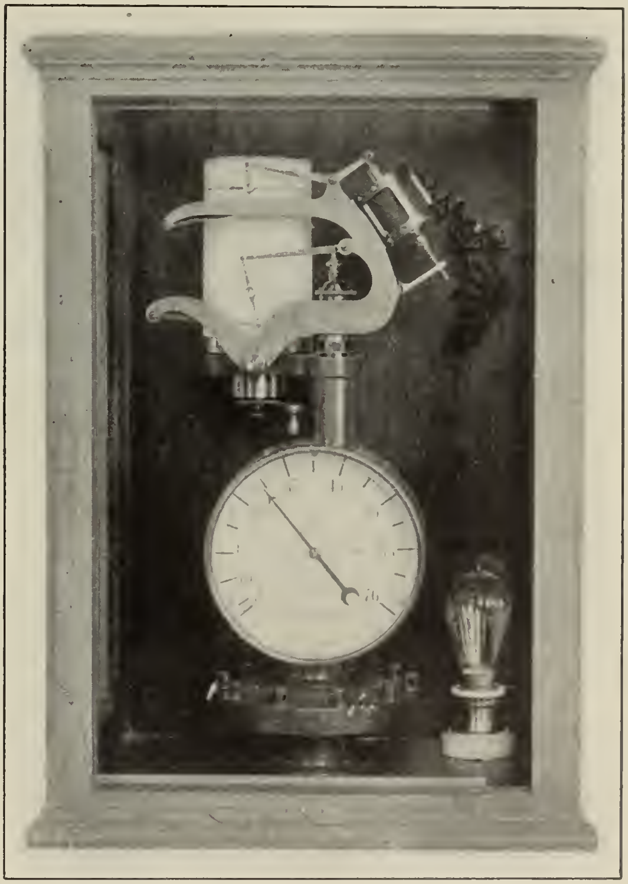
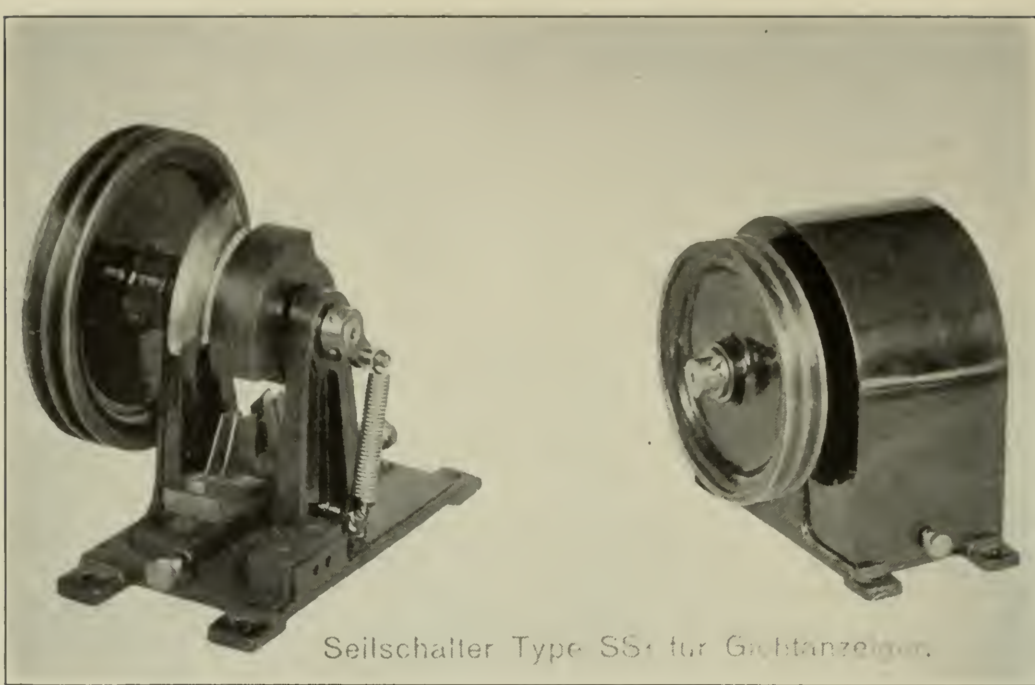


FIG. 16. REGISTERING SUMP GAUGE.
Union Elektricitäts Gesellschaft.



ROPE-ACTUATED SWITCH FOR SUMP GAUGE.

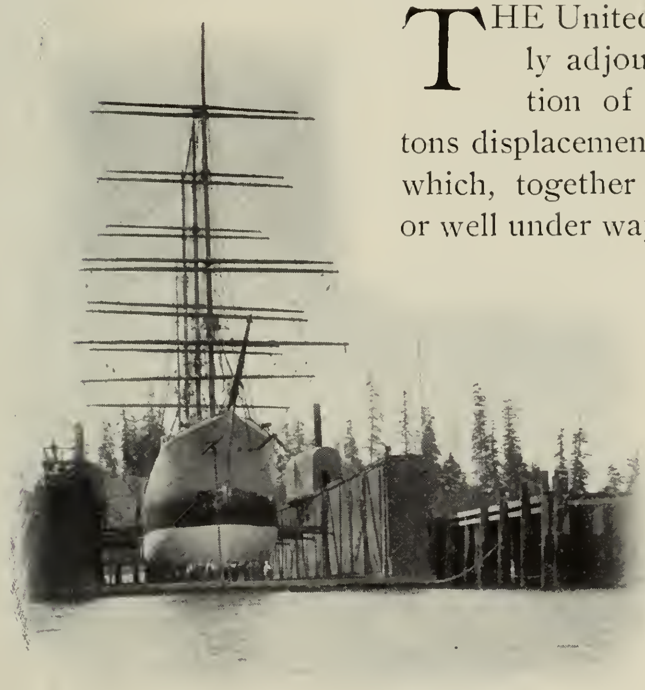
and sounder. The electric transmission of signals has the advantages of promoting safety, of permitting the rapid transmission of orders, and of establishing a bond between the various parts of the mine and the office of the mine manager. Other electric apparatus —revolution counters, gauges of the depth of water in the sumps, wagon counters, etc., serve further to keep constantly in view in the office the general progress of the work everywhere in the mine.

The secondary applications of electricity to mining, it will be apparent, are of much importance; but far more so are the primary applications, as we shall see in a succeeding article.

DEVELOPMENT IN FLOATING DRY-DOCKS.

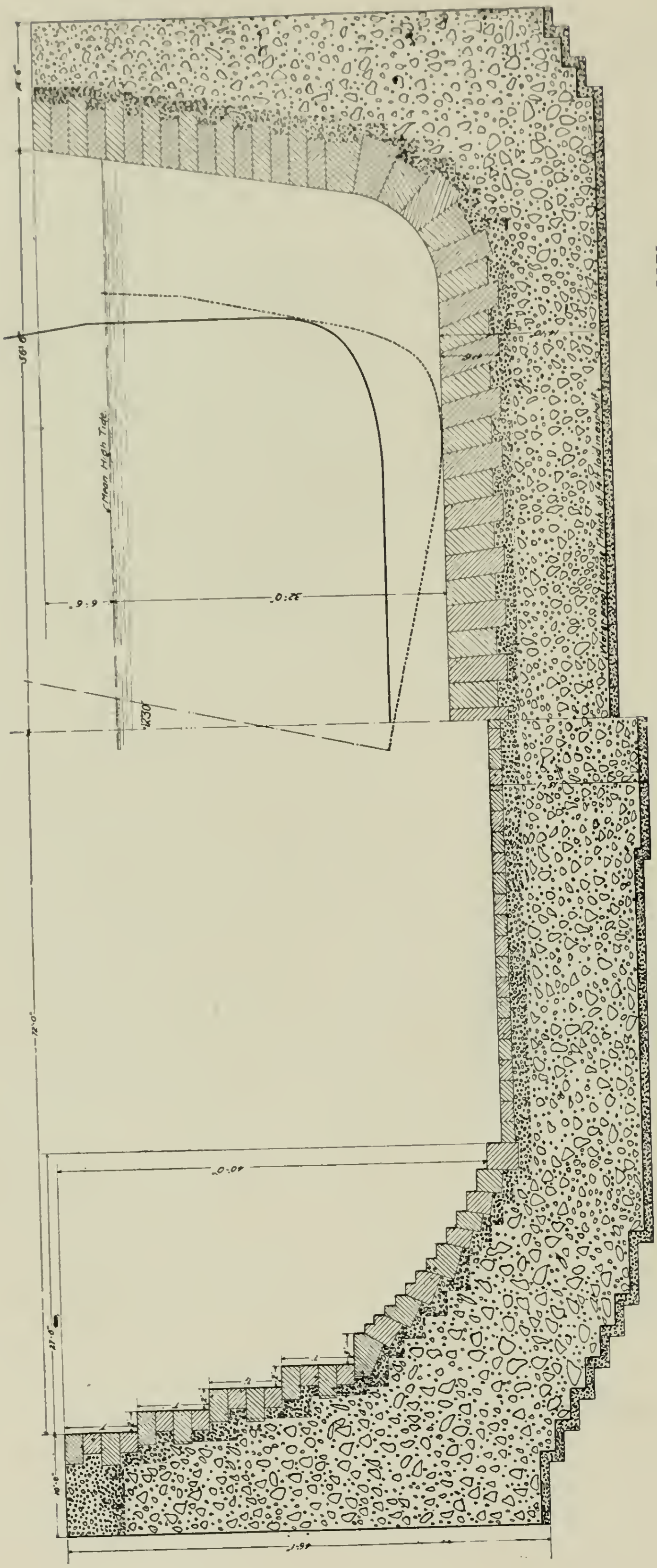
By Joseph J. Shultz.

The importance of adequate docking facilities to commercial expansion—to say nothing of the very vital question of their essentiality to naval defence—was emphasized in this Magazine by Mr. Foster Crowell in a series of papers published in 1897. Mr. James McKechnie, in his admirable review of British ship-building which appeared in our pages early in 1898, referred to the dry-docks of the United Kingdom as a very important factor in the expansion of Britain's marine interests. Mr. Schultz's article is specially significant in showing how effectively the marine architect and naval constructor have come to the aid of the civil engineer in affording a readier answer to this pressing problem.—The Editors.



THE United States Congress that has lately adjourned authorized the construction of three battle-ships of 16,000-tons displacement each, and two of 13,000-tons which, together with the ten just completed or well under way, will enable the United States to hold its position of third as regards tonnage among the world's naval powers. These are large additions, but the new demands laid upon the navy in providing adequate protection to a greatly extended territory and in maintaining properly a world-power dignity justify them. The fact, however, must not be lost sight of that, unless the facilities for keeping these fighting machines in the highest possible state of repair and efficiency are commensurately increased, the new vessels themselves will be of no more value than if at the bottom of the Pacific Ocean.

The only means of thoroughly overhauling a vessel is by placing it in a dry-dock where its sides and bottom are entirely exposed and where its equipment may be carefully examined; and, in Europe and America as well, docks have hitherto been almost exclusively of the "graving" type—excavations made in earth or rock and lined with



SECTION OF GRAVING DOCK, SUGGESTING THE DIFFICULTY OF DOCKING A CAREENED VESSEL.

masonry, timber, or concrete, and closed at the entrance end by a removable gate or caisson. These have served their purpose admirably, but they cannot fulfill the exigencies created by modern naval and maritime development.

The following comparison gives the relative advantages of this type of dock and its successor, the steel floating dry-dock.

The Connecticut may be taken as a type of the modern battleship. This is 450 feet in length, of 77 feet beam, has a draft of 27 feet and a displacement of 16,000 tons; but some of the auxiliary cruisers, which on account of their speed are of the greatest importance in time of war, are 600 feel long; and therefore a dry-dock capable of accommodating any naval vessel with ample light and room for making the repairs must be at least 750 feet in length, 100 feet in width, and have a clear depth over the entrance of at least 32 feet at mean high tide. Several naval docks now under construction fulfil these conditions except as to length, and the longest is only 600 feet. Be it observed, however, that the above docks will accommodate such a vessel as the Connecticut only under perfect conditions, i. e., normal displacement, even keel, and high tide.

In peaceful times such conditions are easily obtainable, but during a war a vessel may be crippled, and still float, to the extent of being submerged five or six feet below its mean displacement line, and have a list of 20° or 25°, which on account of the perfectly flat keel would still further increase its draught five feet and add very materially to its beam as is shown by the mid-ship section of the Connecticut in Figure 1. This would debar the vessel absolutely from every dry-dock in the world, and therefore compel its abandonment simply from the lack of proper docking facilities. It is also seen from Figure 1, that a list of only 12½° at normal displacement would prevent the vessel from entering the largest dock in the United States. This condition is one that is very likely to occur in a naval engagement, and the necessity for providing means for docking such vessels is self-evident.

A glance at the accompanying cross sections through the body and entrance of a graving dock with 32-feet clearance at mean high water will show that further increase in depth is prohibited on account of the immense addition of masonry that would have to be made in order to withstand the added pressure on the sides and at the caisson seat. No such obstacle, however, stands in the way of building a floating dock to meet these conditions. In a graving dock the walls and sides must be designed not only to withstand the water and earth pressure upon them, but to provide sufficient dead weight to balance the entire amount of water displaced by the dock, while the sides and bottom of a similar floating structure need have only sufficient lateral and longitudinal stability to sustain the actual weight of the vessel; the walls do not take one pound of water pressure, and the bottom only that due to the combined actual weights of the dock and vessel. There is therefore no prohibitive depth in the construction of a floating dock—for with a given lifting capacity, to obtain an increased draft over the keel blocks, the bottom remains exactly the same and only a corresponding increase is necessary to be made in the height of the sides, thus securing by the greater girder depth a stronger and more rigid structure than before.

From the standpoint of necessary depth, therefore, the floating dock is the only resort, and it posseses as great an advantage over the

THE BERMUDA FLOATING DOCK LIFTING H. M. S. SANS PAREIL.

Built by Swan & Hunter, Wallsend, Newcastle-on-Tyne.

graving dock in point of length. It is a significant fact that, until the completion of the 700-foot floating dock by the Morse Shipbuilding Company, there was not an American ship-yard where the longest Atlantic liners could be safely docked. This contracted length of the commercial graving docks is due to the fact that they must be built nearly normal to the water front and wholly in solid ground, and the depth of the yard, limited by the enormous value of water-front property, is insufficient to contain longer ones. A floating dock, however, can jut out into the water to the harbor commissioner's line and its limitations in length are, therefore, only those determining the dimensions of the ship; for if a vessel can be constructed of sufficient rigidity to withstand the rigors of a stormy Atlantic passage, a floating dock operating in still waters and subjected to static loads only can certainly be built long enough to lift that vessel safely.

Consider further, however, that repairs on a vessel damaged as above, to be effective, must be made at once—one cannot wait for a high tide or to tow it a long distance. Therefore a third advantage is the ready accessibility of a floating dry-dock. The condition of the tide does not affect its clearance over the keel blocks and the site is not dependent upon the character of the ground. The best location for a graving dock is one where the foundations are of stiff clay, gravel, or rock, and although docks of this type can be and are built upon piles in some soft foundations, yet it is impossible to construct them in ground where there is an excessive amount of quicksand or where springs are likely to be met with. The dangers of the latter are exemplified by a New York dock, on which $200,000 has been expended for repairs to the bottom and the dock is at present almost worthless although of the best masonry and completed only a few years ago. On the other hand, a floating dock can be located anywhere there is sufficient depth of water to allow its sinking deep enough to take on the vessel. Further than this, in a war the floating docks could be towed to those points which are likely to be most accessible to the naval operations, and if necessary a dock could even be taken out to meet a damaged incoming vessel which could be docked in the open sea as soon as overtaken—a feat that has been accomplished several times. Repairs could thus be made quickly enough to save the vessel and allow it to go again into action; and it is very probable that most, if not all, of Spain's ill-fated Cuban fleet could have been saved for the American navy had a floating dry-dock been towed to the immediate vicinity,

H. M. S. SANS PAREIL IN THE BERMUDA DOCK, PARTLY SUBMERGED.

thus permitting them to be quickly moved into it, and temporarily repaired.

In regard to the time required for construction the floating dock also has a very great advantage. Borings may be taken on the site selected for a masonry dock, test piles driven, and the range of the tide gauged. With these data the plans are gotten out, but the greatest difficulties are by no means overcome. The condition of the ground fifty or sixty feet below the surface is not definitely known.

DOCKING THE BATTLESHIP "ILLINOIS" IN THE FLOATING DRY-DOCK AT THE U. S. NAVAL STATION, NEW ORLEANS, LA., JANUARY, 1902.

Built by the Maryland Steel Company.

Springs may be encountered and an expensive and troublesome coffer dam must be maintained across the entrance until the structure is absolutely completed. Consider for example the masonry dry-dock at Boston, Massachusetts. Congress made the appropriation on May 4, 1898; the contract was let on March 4, 1899, but at the present time there is little more than a hole to mark the site and the dock will not be wholly finished for two years more. The same is more or less true of the other three naval docks provided for at that time, while in contrast with this take the floating dock authorized by the same Congress for Algiers, La., the first large structure of its kind provided for by the United States. This has a capacity equal to any of the docks just mentioned and the time elapsing between the signing of the contract and the completion of the dock at the yards of the Maryland Steel Co. was only thirty months, and since January 6, 1902, the dock has been in active operation on the site in Louisiana.

Although an actual comparison of the cost is rather difficult, it may be examined from these standpoints:

First, original cost. For a floating dock the cost of the site is practically eliminated and a suitable berth is all that is necessary. In a graving dock the machinery plant must include the necessary power for operating the caisson and a pumping plant of sufficient capacity to empty the entire contents of the dock, while in a floating dock the entire machinery consists of the valves for controlling the flow of water through the various bulkheads and compartments, and

FLOATING DOCK FOR LOANDA, IN PORTUGUESE AFRICA.
Built in 1896 by A. F. Smulders, Rotterdam.

the pumps for removing an amount of water equal to the weight of the docked ship plus that of the dock—in quantity only one-tenth or one-twelfth as large as the above. A saving in two instances is therefore effected. A comparison of the cost of the masonry or timber and the steel cannot be definite, but the masonry will be about twice as expensive as the steel under the present ratio of prices, and timber about the same price. But most important of all is the fact that a floating steel dock can be built for the estimated cost, while one of the graving type, owing to the large factor of uncertainty attending its construction, almost invariably exceeds the original estimate. The cost of the Toulon masonry dock, which has a working length of 600 feet, was $1,065,000 and the machinery equipment $400,000; the new dry-dock at Charleston, S. C., is to be 575 feet long, of concrete lined with granite, and will cost $1,500,000 complete; the new Skinner timber dock at Baltimore, 650 feet long, cost $700,000, while the floating dry-dock at Algiers—which is capable of taking every vessel accommodated by the above docks—cost complete $810,000 and the new 18,000 ton dock will be built and towed to Cavite for $1,200,000. A graving dock of like capacity would have to be 750 feet long, costing at least $3,000,000 complete at that remote place.

Second, operating expenses. These will be much lower, probably only one-fourth, for the floating dock, because there is far less water to handle and no caisson to operate.

Third, cost of repairs. Of course a floating dock, being entirely of steel, must be given constant attention as regards cleaning and painting; but 1 per cent. per annum of the original cost will cover

THE LOANDA FLOATING DOCK, COMPLETE.

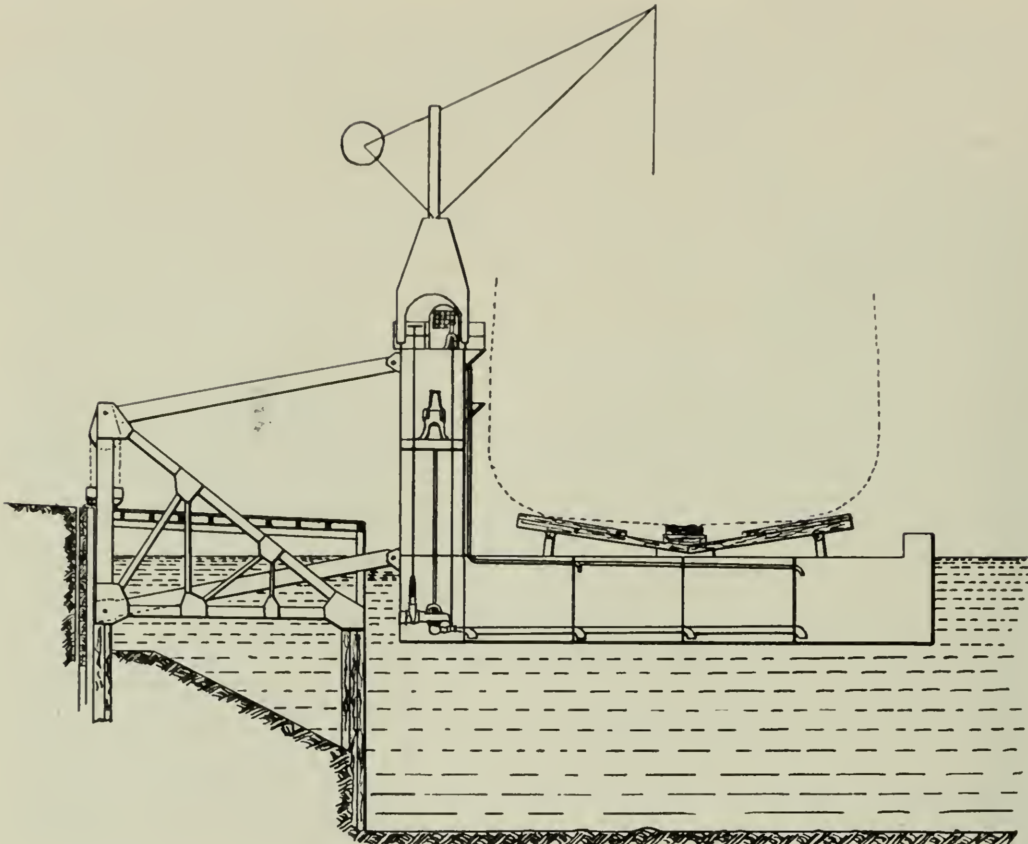
THE DURBAN FLOATING DOCK AT THE BUILDERS' WORKS.

Swan & Hunter, Newcastle-on-Tyne.

these, and it is doubtful whether a masonry dock can be properly maintained at a lower cost, while the necessary repairs to a timber dock will amount to at least twice as much.

From the standpoint of durability the masonry dock apparently has the advantage, but this is only true of graving docks constructed in absolutely solid rock; for under other conditions, even with extreme care in building, their life will scarcely exceed seventy-five years. Consider, however, that there are now in excellent condition several floating docks that have operated continuously for over forty years, and this in the face of the fact that they were the pioneers of their kind. Therefore, with the knowledge gained by the experience of forty years, a floating dock can certainly be built and cared for so as to last at least the same time as the graving dock, and in comparison with the timber dock, which is invariably the type of present American commercial docks, it is safe to say the steel dock will outlast three of them.

In these important points, therefore, floating dry-docks far outclass those of the graving type, and this superiority has been recog-



SECTION THROUGH OFF-SHORE DOCK.

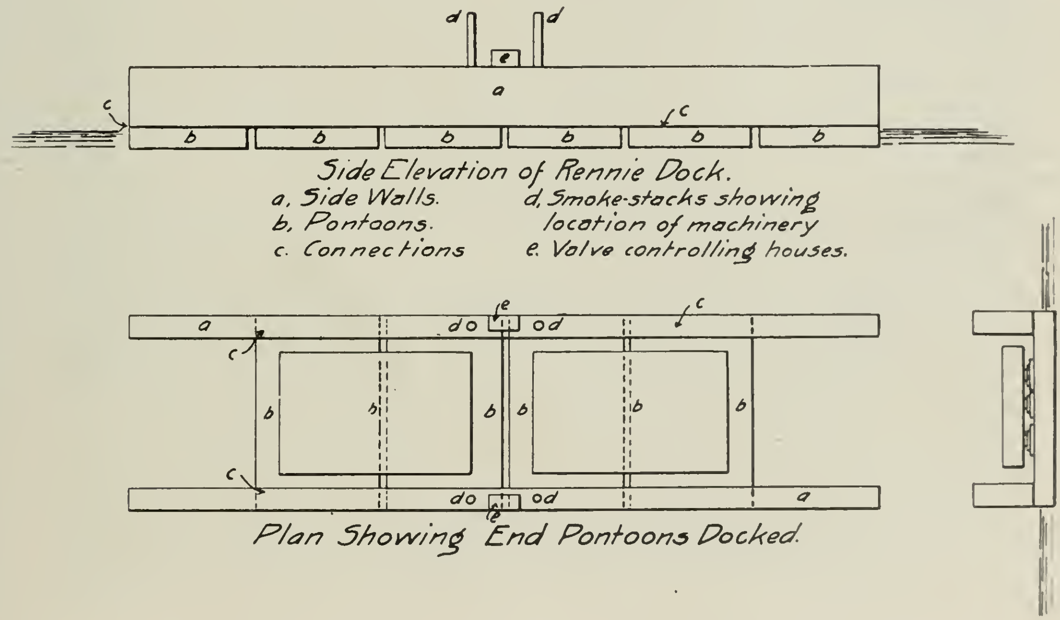
nized for more than a century, although such structures could not be built with sufficient longitudinal and lateral rigidity until iron and steel had replaced wood as the materials of construction.

The first docks of the floating type were built early in the last century and were called depositing docks, consisting of one side only from which projected large teeth upon which the vessel rested while being raised. When clear of the water the dock was floated to an adjacent stationary structure into which the teeth fitted and upon which the vessel was deposited as the dock was allowed to sink. A large number of these were constructed and some are still in use by the Russian and Spanish Governments.

As a logical successor to this, came the "off-shore" dock shown just above. As regards buoyancy this dock is self-contained, but its stability is secured through the shore connections indicated. Such a dock is particularly well adapted to places where economy of space is an important factor, for the vessel is docked from the side and the large amount of dead space required for end docking is eliminated; they are therefore much used in England and Germany's crowded ship-yards—the largest being that at Hamburg, which is 85 feet wide, 320 feet long, of 5,000 tons capacity, and connected to the shore by ten columns.

The double-sided dock, however, is the only type adapted to handling the heaviest class of vessels, because both sides are required to secure the rigidity necessary to prevent a deflection that would be injurious to the contained ship.

Modern docks of this class were used in the United States as early as 1837, but the honor of building the first successful double-sided floating dock entirely of iron belongs to an Englishman, George B. Rennie, who in 1857 designed and constructed one for Carthagena, Spain. This is 320 feet long, 79 feet wide inside, 48 feet high outside, and has a draught of 24 feet 6 inches over the keel blocks, and a capacity of 6,000 tons. As a test, immediately after completion, the Numancia, a ship weighing 5,600 tons, was docked in it and kept on the blocks for 80 days without any defect being discovered, and the dock is in excellent working order at the present time. Mr. Rennie also first demonstrated that the present ⊔ shaped cross section is the most economical and at the same time the most stable section for structures of this character. His docks consist of continuous side

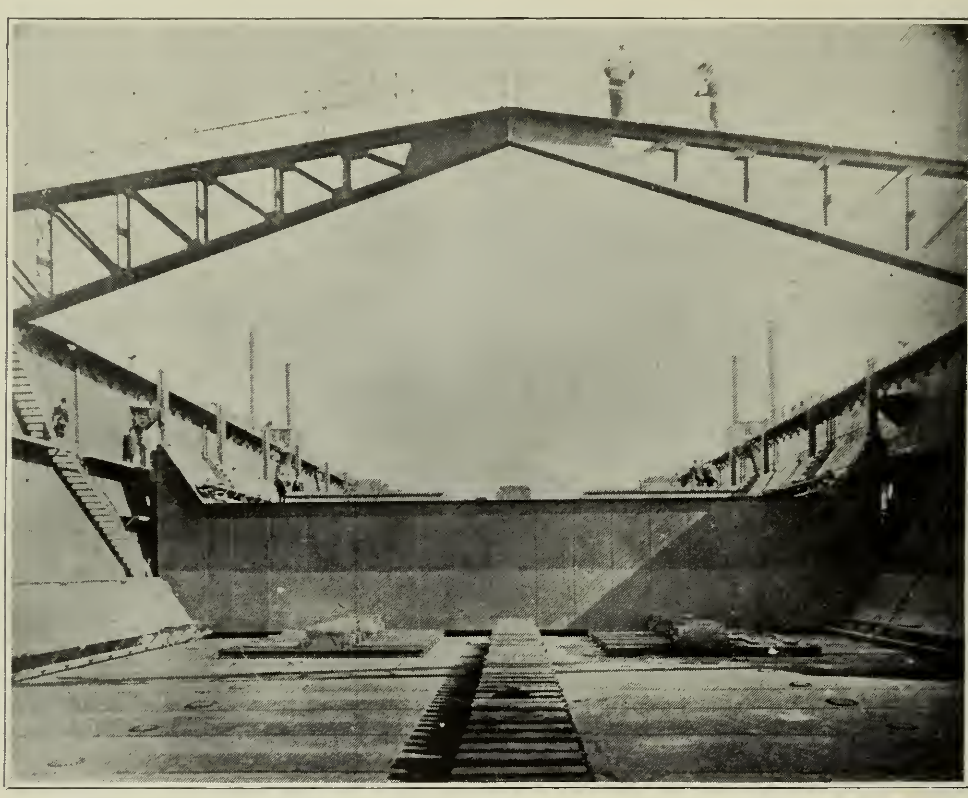


ELEVATION, PLAN, AND SECTION OF RENNIE DOCK.

walls supported upon and securely bolted to a number of pontoons which furnish the structure's buoyancy—the entire rigidity being imparted by the walls. His design also marked a step in advance, in that these pontoons were removable and could be self-docked, and thus repaired.

This is one of the most important features of a floating dry-dock, for the life of the structure depends upon the thoroughness with which repairs are made to the under-water portion. On page 683 there is given a general side elevation of the Rennie type of dock and the plan shows the two end pontoons self-docked. This operation is very easily accomplished, for it consists simply in sinking the dock a little way, unbolting the fastenings of a pontoon, floating it from under the side walls, and then further sinking the dock sufficiently to allow the pontoons to take the blocks, when all necessary painting and repairs can be made.

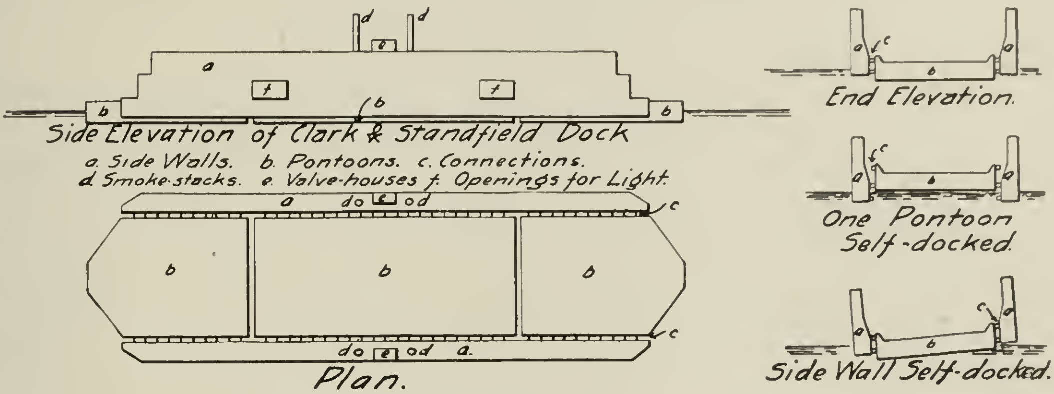
A number of docks have been constructed upon this plan, the largest being that built for Messrs. Blohm & Voss at Hamburg, which has a capacity of 18,000 tons exclusive of its own weight. Several were built from 1865 to 1890 with slight modifications—the most im-



SELF-DOCKING THE MIDDLE PONTOON OF THE NEW ORLEANS FLOATING DRY-DOCK.

portant of the latter class being that designed by Tramwell in 1867, for St. Thomas, Danish West Indies. This was open-sided, part iron and part wood construction, and though in use today is very clumsy to manipulate in docking a vessel and in self-docking its own pontoons.

About 1896 Messrs. Clark and Standfield, an English firm, who had hitherto designed docks of the depositing and the off-shore type, patented a kind of floating dry-dock which differed from the Rennie dock in that the side walls were not supported upon the pontoons but were fastened to their ends, and the self-docking was accomplished by raising the pontoon a small distance vertically. The Algiers dry



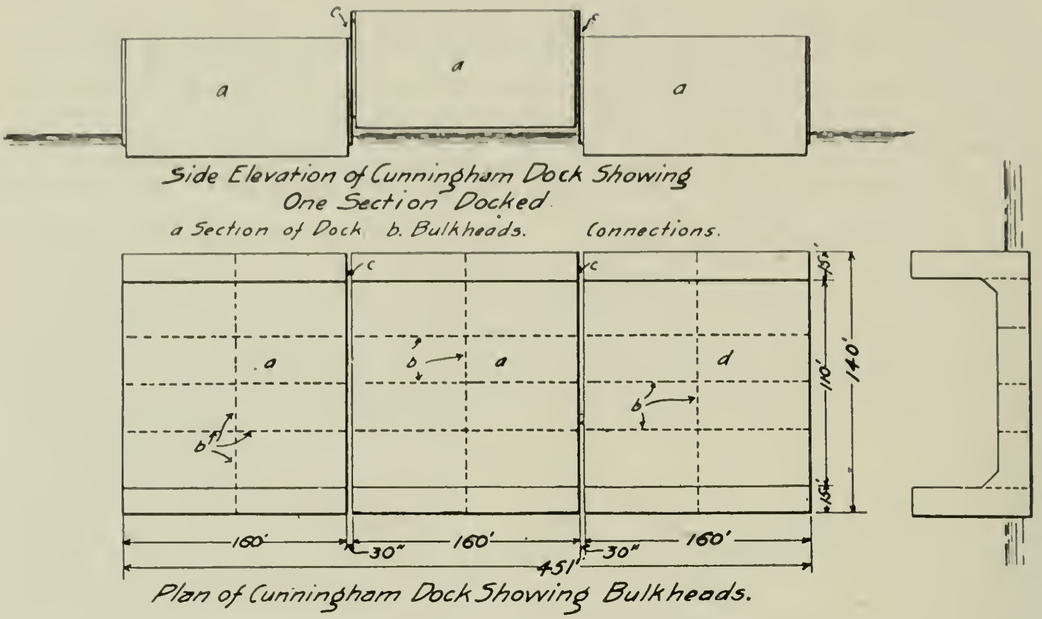
ELEVATION, PLAN, AND SECTIONS OF CLARK & STANDFIELD DOCK.

dock is of this class and the longitudinal and transverse elevations in this page indicate the general construction, while page 684 shows one on the pontoons self-docked, and the illustration on page 678, the U. S. S. Illinois in dock. Since 1897 this firm has designed four other docks of 12,000-tons capacity.

It remained, however for an American inventor, Lieutenant Andrew C. Cunningham, Corps of Civil Engineers, United States Navy, to design and patent in 1902, a floating dry-dock introducing new features that will expand the field of usefulness of these structures. The general characteristics of this new type are shown in Figures 8 and 9, and while no docks of this design have been constructed the United States Navy Department recently awarded a contract for the new 18,000-ton floating dry-dock for the Philippines on a bid upon a dock of the Cunningham type.

Essentially this dock is composed of several sections, each of which is a complete dock in itself; and the walls and bottom of each section are continuous, thus securing the strongest and most rigid construction with the least amount of metal. The connections between the several sections are ordinarily above water and are so located as easily to be made stronger than the walls themselves. One form of fastening proposed by Lieutenant Cunningham is shown in Figure 10 and consists of 6 feet by 6 inch angles fastened together by plain 2 inch bolts.

In the Cunningham dock the self-docking of the sides and bottom is

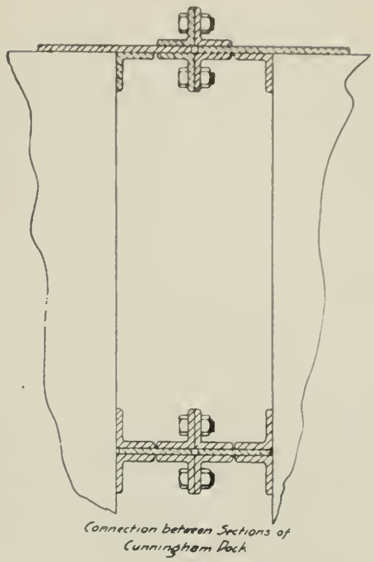


ELEVATION, PLAN, AND SECTION OF CUNNINGHAM DOCK.

accomplished at one operation while in the others two or more are necessary. The method is: The several sections are pumped to an approximately even keel; the bolts of the part to be docked are loosened and removed, and the remaining sections allowed to sink partially—the loose section being guided vertically by the bolts through the slotted holes in the connection angles. The sections are then reconnected and the two end portions pumped out, thus bringing the docked section to any height desired above the water.

The section adopted does not involve the use of any unusual shapes and it is possible to construct the entire dock by employing only the ordinarily rolled commercial steel sections. This not only reduces the cost but facilitates construction and cuts down the time for completion to a minimum.

Since the dock is composed of independent sections, its length may be adapted to the ship which is docked and a great saving in operating expenses can hence be secured. But of far more importance is the fact that in docking short heavy ships, the cantilever ends of the dock, extending beyond the ends of the vessel, which are so frequently strained injuriously in the Rennie and Clark docks because they do not have the same lifting power as the remaining portions, are left off; and the entire length used, (which is only that necessary to develop the requisite buoyancy), is then subjected to the same stress and the deflection reduced to a minimum. From a naval standpoint the division into several sections is very desirable, for the various parts may be distributed in time of peace among a number of naval stations, and in case of war they can be quickly towed to a common place for assembling and docking the largest vessel. From a commercial standpoint they are even more valuable, for by providing a reasonable beam and draft a small capacity can be started with and this increased as larger patronage is obtained, finally securing a dock capable of taking the largest liners and at the same time very easily divided to dock several small vessels.



CONNECTION BETWEEN SECTIONS OF CUNNINGHAM DOCK.

With the possibilities afforded by docks of the floating type, therefore, a large number of commercial dry-docks can be built and thus remove one of the chief hindrances to the development of American shipping—the great lack of repairing facilities in American ship-yards—and there can also be provided on every one of the American island possessions, and at other convenient points on the sea-coast, good, complete repairing plants for the Navy and thus make it as strong in time of war, when quick repairs are of as great value as ships, as it is in these peaceful times.

Flying Ferry near Arayat, Installed by Engineer Troops.

MILITARY ENGINEERING AND CIVIL OPPORTUNITIES IN THE PHILIPPINES.

By Captain William W. Harts.

The engineer is nowadays practically the pioneer of civilization, and has therefore a foremost interest in the knowledge of the conditions and opportunities in new countries. Captain Harts' article will appeal to the reader by the definite suggestion it makes upon these points.—The Editors.

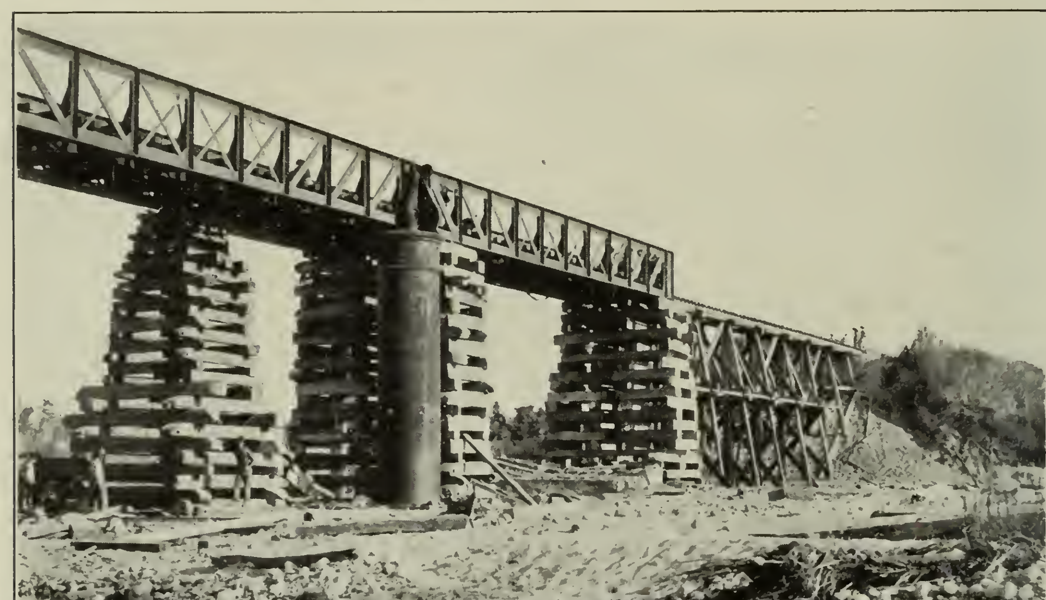
SINCE the arrival of the first American troops in the Philippines, the work of the engineers has been arduous and varied.

From the first march of the American troops from Cavite to Manila, when the city was captured, up to the present, they have been busily engaged with whatever problems their training could solve. On this first march, they removed the Spanish and insurrecto trenches from the line of march of the army, reconnoitered the positions of the enemy, prepared bridges and fords, and even took a share in the attack on the place. Later, when the Filipinos became hostile and attacked the American lines, the hasty repair of bridges destroyed by the insurrectos, laying out camps and lines of defence, constructing military roads and bridges, making surveys and supplying maps, were some of the more important duties that fell to their lot. The photographs herewith show some of the work on which they have been engaged.

In the early days of the American occupation, the restoration of the Manila and Dagupan Railway was an important work, as the first advance northward was made along this line and the road had to be used as a line of supply. This road had been badly wrecked by the insurgents, and in several instances bridges had been wrecked by dynamite and rolling stock purposely piled up in a mass of debris. This railway was quickly put in good condition, however, by the engineers and operated by them until finally turned over to the owners. Later the supply of the many garrisons made necessary by the wide occupation of territory made supply roads imperative. Hundreds of miles of road in the island of Luzon, alone, were repaired and made passable, also a great number of bridges were built. These roads and bridges were partly of hasty and temporary construction, but some were made durable and permanent, depending on the needs of the troops.

BRIDGE OVER AN ARM OF THE RIO GRANDE DE PAMPANGA, ONCE BURNED AND ONCE WRECKED BY INSURGENTS AND TWICE REBUILT BY THE ENGINEERS.

ROLLING STOCK OF MANILA & DAGUPAN RAILWAY, WRECKED BY INSURGENTS AT BAMBAN BRIDGE. LATER REMOVED AND PUT INTO USE BY THE ENGINEERS.



BRIDGE ON MANILA & DAGUPAN RAILWAY, DESTROYED BY INSURGENTS AND PLACED IN CONDITION FOR TEMPORARY USE BY ENGINEER TROOPS.

The road in Mindanao from the coast to Lake Lanao has been practically completed, and a feat believed impossible by the Moros has been accomplished. This has already had a very sobering effect on their warlike aspirations and will be a strong argument, easily comprehended, in case of further restlessness on their part.

BAD ROAD IN BATANGAS PROVINCE, HUB DEEP IN MUD. LATER MACADAMIZED BY THE ENGINEERS.

A finely macadamized road, about thirty-six miles long, has been built from Calamba to Batangas in the provinces of Laguna and Batangas, and another about twenty miles long in the province of Albay. Extensive road and bridge construction has been carried on in the provinces of Pangasinan, Bataan, Nueva Ecija, Pampanga, and South Camarines—in fact there are few provinces in Luzon where valuable work has not been done on the roads and lines of communication. In all, something like nine hundred miles of road have been built or im-

REBUILDING RAILWAY TRESTLE CARRIED AWAY BY A WASHOUT NEAR TARLAC.

proved in Luzon. In many cases this required the construction of extensive causeways through rice marshes.

Although excellent timber, suitable for bridge building, is to be found in most provinces, it is difficult to obtain speedy delivery at the points where needed; besides, all timber must be dressed by hand. It was therefore found expedient to import Oregon pine from America, which was largely used for bridges, many of them being constructed to standard plans in Manila and shipped, "knocked down," to the sites and there erected. In all this road and bridge work, natives were em-

CROSSING AN IMPROVISED BRIDGE NEAR MALOLOS.

ployed in large numbers and divided into squads, over each of which an engineer soldier acted as overseer. Non-commissioned officers of engineers were charged with general supervision over several squads, and all the engineer work in a single district, usually embracing several provinces, was placed in charge of an engineer lieutenant who received his orders from the engineer officer of the department. Thus a complete line of responsibility and control was arranged which has worked very satisfactorily in practice.

BRIDGE HASTILY ERECTED NEAR CAPAS BY THE ENGINEERS.

About $400,000 Mexican has been expended during the last year and a half on this work in Luzon.

In most places, suitable rock has been very scarce, making the cost higher than elsewhere. The best results have been generally reached by placing a foundation, from eight to twelve inches thick, of "dobie" stone, which is a soft volcanic tufa and the best available in most places, and then covering this three to five inches thick with coarse river gravel and then rolling it. Such roads, sixteen feet wide, cost about $5,000 Mexican or $2,000 United States currency per mile and last as long as the top dressing is continuous and properly cared for. A curbing of small boulders, where practicable, or else of dobie stone, is set in a shallow trench to prevent the road from spreading. When properly graded, ditched, crowned and cared for, these roads are very satisfactory. Usually extensive fills are necessary to raise the roads high enough above the surrounding rice paddies to keep them dry in the wet season.

Since the islands were turned over to the civil government in July, 1902, much of this road work has passed into the hands of the provincial supervisors, who, it is hoped, when conditions become more settled will take up energetically the very necessary work of maintenance.

HAULING A FIELD PIECE ACROSS A TEMPORARY BRIDGE IN THE ADVANCE ON MALOLOS.

The construction and maintenance of good roads, especially of trunk lines, has a very important military as well as commercial value and ensures peaceful conditions in a way accomplished by no other means involving the expenditure of the same amount of money.

For the purpose of housing troops in permanent garrisons, sites for the new military stations have been surveyed and mapped, arrangement of buildings designed and water and sewerage systems investigated and planned. A careful examination of the islands of the archipelago for coal has been made. A wharf has been built at Zamboanga, and others are being built by the engineers at several different ports. Plans and estimates for the deepening of several river mouths have been

BRIDGE NEAR CALOOCAN ; THE ARCH, DESTROYED BY DYNAMITE BY THE INSURGENTS, IS BEING REPAIRED BY THE ENGINEERS.

RAISING A LOCOMOTIVE WRECKED BY THE INSURGENTS NEAR ANGELES.

GUARDING THE WOUNDED, WHILE BEING BROUGHT IN DURING RECAPTURE OF THE WATERWORKS.

GUNPIT AND 3-INCH GUN OVERLOOKING MARIQUINA VALLEY, PROTECTED BY SAND-BAGS MADE OF NATIVE GRASS.

HASTILY BUILT BAMBOO RAFT.

BRIDGE STRIPPED OF FLOORING BY RETREATING INSURGENTS; FORD PREPARED BY ENGINEERS.

BAMBOO FERRY ON THE RIO GRANDE DE PAMPANGA, BUILT BY THE ENGINEERS.

made, and the port of Manila is now being extensively improved under the supervision of army engineers.

The civil engineering work in the city of Manila, a city of over 300,000 people, has been largely designed and executed under army engineers, including the building of new public markets of steel, a new steel bridge over the Pasig River, a public crematory, and model tenements.

The work of the engineers in the Philippines is just commencing, and many excellent opportunities are already beginning to show themselves. Railroads and street tramways must be built, coal and other minerals mined; Manila must have a new water supply and a sewerage system; other towns must have the same, and the construction of roads and bridges must be continued.

As soon as the future control of the islands becomes more settled, and the permanency and wisdom of the present government is sufficiently assured to warrant investment of capital and the extensive introduction of modern machinery to develop the industrial and mineral resources of the islands, an attractive and profitable field will be opened for members of the engineering profession.

A REMODELED PIECE-WORK SYSTEM.

By John H. Van Yorx, Jr.

Mr. Van Yorx will impress the practical shop manager by his eminent practicality. He frankly recognizes that there is no panacea for labor troubles—that some of the fundamental difficulties will remain as long as human nature is what it is, and that the best that can be done is to be just and to reduce the inevitable friction to the minimum possible. It is hardly necessary to add that the system described is in actual use.—THE EDITORS.

AS the demands of prosperity increase, the demands for a greater output and a cheaper product also increase. Not only technical magazines but even ones outside of technical lines are today dealing with this subject in innumerable lights, in their attempts to solve the many phases of the trouble between capital and labor. They are largely attempts to satisfy fully both capital and labor. The attempts have failed and will fail until human nature changes.

If it were possible for men, whether of capital or labor, to become satisfied and contented the next thing human nature absolutely dictates is to rest, with the result that the world stands still. There I would say the attempt to establish a system in a manufacturing concern which will satisfy both employer and employee is an attempt along false lines. What then is there to be done? At the present day this and this only: to establish a system which moves with the least possible friction to gain its end (that is all that can be done with the best piece of machinery ever built), and which at the same time does justice to both employer and employee.

One of the great troubles today lies in each realizing that the other wants as much of the benefits of the increase of production as he can get, and so suspicions and distrust are aroused. The system of which a general outline is here given is not a cure for all ills—not a thing to stop all "kicking"—but a help and a help only for existing conditions, one that will make the workman feel and understand that the company is willing to pay him for his efforts. Nor is originality claimed for it, as it is the result of conclusions drawn partly from the study of different plans, and partially from knowledge and experience gained by personal contact with the system as used in a certain well-known machine-tool company. It is another form of applying well-known things, and there are undoubtedly many shops with as good a system perhaps as here shown, if not indeed a better one. On the other hand, there may prove to be something which will be suggestive.

Upon first appearance this system may seem to be complicated and unwieldy; but it deals with detail; detail is necessarily voluminous, but detail is the thing an up-to-date shop must have at the present time. Red tape is a thing necessary in carrying detail, but red tape should be reduced to the smallest amount possible. This seems to be largely lost sight of in many systems with their multiplicity of forms and unnecessary amount of clerical work to carry this detail, both in and out of the office. One of the advantages to be derived from this system is that it uses condensed forms and does not turn the mechanics and foreman into clerks. Immense loss is caused by systems requiring the foremen to spend hours writing that which should be done by clerks, instead of attending to the direction of their rooms. It is not an uncommon sight in some factories to see a number of men standing about from five to fifteen minutes awaiting a job or some direction in their work, either of which should have been ready for them when it was needed, while the foreman was writing a requisition for a piece-work contract, or entering the general information as to what a piece of work is and to what it is to be charged, etc., for the benefit of the next department. Here again is additional loss caused by the rewriting of standard information every time a piece changes hands. One of the objects, therefore, to be gained by this system is to reduce the amount of clerical work which the mechanic is generally forced into, and to transfer it to the hands of clerks to be done in as concise and compact form as possible. As far then as this system is concerned, the foreman's writing will consist of the information needed for temporary use, namely, the man's name, the date, and the time of starting. If the number of machines that the workman runs is liable to change, then the number of machines should be written.

A piece-work system is dependent upon other systems in the shop for its quietest running, as a machine is dependent upon its several parts.

In what follows price will be spoken of for convenience of expression although standard time is favored instead of price.

Before placing or changing a system in a shop, it should be carefully prepared and as nearly perfected as is possible for an untried thing. If this is not done and a system is put into operation in a partially prepared state, then in addition to the natural difficulies which are bound to arise, is added the confusion due to incompleteness and the accumulation of work awaiting the perfection of the system. This will cause dissatisfaction and delay which, if not remedied, will lead to defeat. The fighting should not begin until the decks have been cleared for action.

The first step is to give each machine that is manufactured a distinct symbol. What this symbol, which classifies the work, should be, depends upon existing conditions; it might be a letter or a figure, as best suited. This symbol when once fixed upon should follow each part wherever it goes in the shop; then whenever it is seen it will instantly be recognized as a part of some particular class of work.

The next step is to separate each machine into divisions, which will give the general location of the parts. The line should be sharply drawn between divisions, for if there is any uncertainty there will be confusion of records in the office and misunderstandings in the shop. Then each separate piece of each division should be numbered, starting at some well adapted part, such as the bed or base of the machine; the different parts should be numbered consecutively following a natural order through the machine, each washer, screw, etc., receiving its number. The number with the machine symbol once given should be the only thing by which the pieces are recognized. If names are used, confusion is bound to arise. After becoming accustomed to the numbers they are much more convenient and less confusing than names, as any foundryman will understand. One case to illustrate—a set of eight clutches, all of different sizes, operated by a pull pin; the tangles these records could get into in attempting to distinguish them by name were marvelous.

The pattern number and piece number should be the same, and they should be numbered in that manner in the drafting room, together with the symbol. The drafting room is the only place where that work can be properly done, as there is where the machines are designed or altered and there it is definitely know whether a piece or screw is to be used on more than one machine or in more than one place. Thus it is for them to start the system right by giving like pieces the same number, so that no possible confusion of prices can

Machine 30" Lathe Division Headstock Sheet No. 1.

Symbol K Job No. 1200-1225-1250

REQUIRED			NUMBER		OPERATIONS							PIECE	LOCATION OF PIECE
NO.	MAT.	SIZE	PATTERN	DRAWING	A	C	M	FT	CH	RT	F	NUMBER	
1	M S	4½, 4¾		9846	1	1	1	1	1	2	1	80	Main Spindle

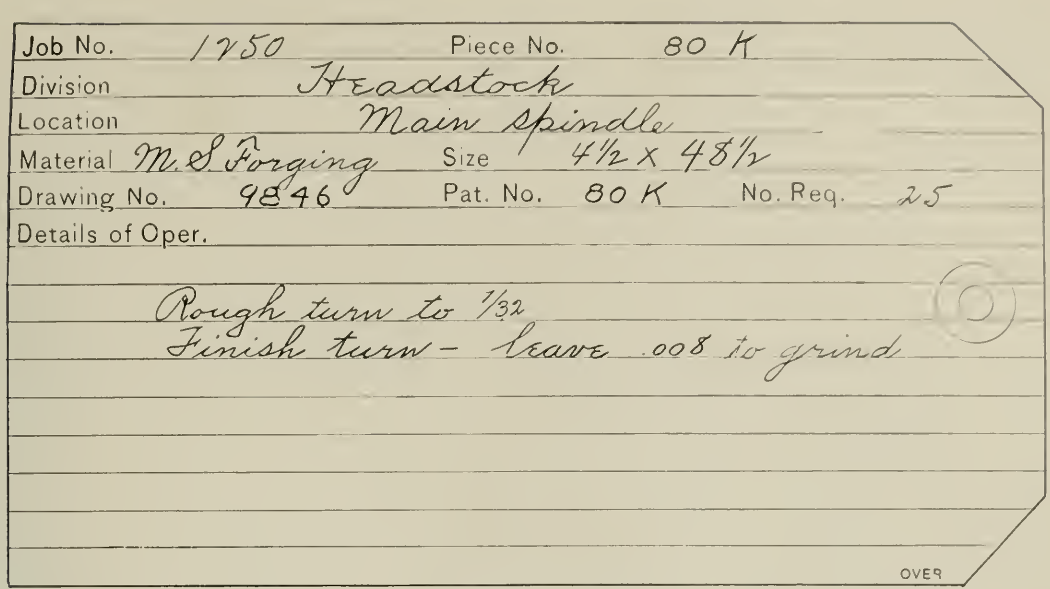
FORM I. INDEX LEDGER SHEET. 12 BY 15 INCHES, ALLOWING A WIDE MARGIN FOR LAYING OPEN.

Red and blue rulings, heavy white paper. Under operations, the upper division is the operation symbol, the lower division shows the number of envelopes in file each with a different process of doing that operation.

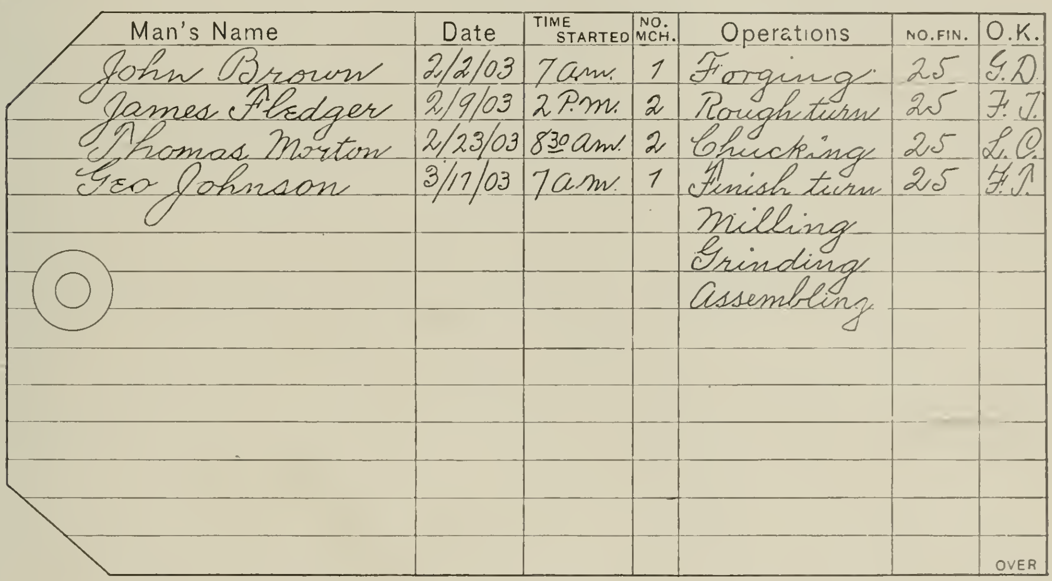
arise. The confusion caused by placing prices upon pieces and carrying parallel records and trusting to chance for their proper adjustment is a fault of some systems.

With the information thus obtained, together with such information as cannot be carried conveniently in the file—such as number required, sizes, material, and any other information that may be found necessary—the books are made up. These books as shown in Form 1 are an index to the file. These books should be of the detachable-leaf variety and be so arranged that one would be able to gain all the information desired at a glance. That is to say, if the piece number, operation, division, symbol, size, material, etc., were wanted they might be had without looking in more than one place for them.

We are now ready to start a piece of work through its shop career, and for our illustration we will take the main spindle of a lathe. The person in charge of starting the work takes the routing tag, as shown in Form 2, and attaches it to the rough stock, which is ready for the



Job No. 1250 Piece No. 80 K
Division Headstock
Location Main Spindle
Material M. S. Forging Size 4½ x 48½
Drawing No. 9846 Pat. No. 80 K No. Req. 25
Details of Oper.
Rough turn to 1/32
Finish turn – leave .008 to grind
OVER



Man's Name	Date	Time Started	No. Mch.	Operations	No. Fin.	O.K.
John Brown	2/2/03	7 a.m.	1	Forging	25	G. D.
James Fledger	2/9/03	2 P.m.	2	Rough turn	25	F. J.
Thomas Morton	2/23/03	8³⁰ a.m.	2	Chucking	25	L. O.
Geo Johnson	3/17/03	7 a.m.	1	Finish turn	25	F. J.
				Milling		
				Grinding		
				Assembling		

OVER

FORM 2. ROUTING TAG. 3¼ BY 6 INCHES, STRONG HEAVY MATERIAL TO WITHSTAND SHOP WEAR.

One side carries information, the other gives the route and history of a piece from start to finish.

first operation of forging as shown by the route on the tag. This routing tag is the connecting link between the order and tracing department and the piece-work department, which carries all of the information necessary to take the work from department to department to completion. When the work is completed the consecutive history should be shown upon the tag, whether it has followed its route, where the pieces were short in number if any, and if inspection should have shown poor or careless workmanship, the tag should show the name of the workman who did that operation. This tag should never leave

Receipt for Balances on Contracts Due April 11 '03

Contract No.	Amt.		Contract No.	Amt.		Contract No.	Amt.	
8542	13	75						

Date April 13 '03 Total Amt. $ 13.75

Received Payment Geo Johnson

OVER

Date 4/11/03 Name Geo. Johnson

Remarks Not here payday, rec'd money 13th.

FORM 3. PIECE-WORK CONTRACT, 3 BY 5 INCHES.

Duplicates of different colors, one retained in the office the other goes to the man. The front is the contract, the back is for the time. For prices not standard same form of another color is used.

the work except to act as a requisition for piece-work contracts, to which use the foreman of the forging department puts it as soon as he knows which of his men will do the work. As long before the man actually begins the work as is practicable the foreman should place the tag in a receptacle for that purpose to be taken to the clerk who makes out the contracts, by a messenger who makes half-hourly trips throughout the shop, taking and delivering messages as well as piece-work contracts. This can be easily done by the foreman as he prepares the job for the men, for he must refer to the tag for information. He will need only to write the man's name and the time of starting.

Upon the tag being placed in the hands of the clerk, the contract should be immediately made out in duplicate, preceding any other duty. This contract is shown in Form 3. The price is then put upon the job and one of the contracts is returned to the foreman at the earliest possible moment. The duplicate contract, which should be of a different color from that which goes to the man, is retained in the office. No contract should be placed in the hands of a workman without a price, unless by special arrangement.

The price should be set by a man who can get out into the shop and find the particular way that a piece is done and the conditions that enter into its production. The foremen should not be burdened with this, as they are in many cases, principally because they do not have the time to attend to it properly; they do not have the details of record at hand, nor would there be uniformity of prices as compared with other departments. The price setting should, however, always be done in co-operation with the foreman in charge, although the decision of the one setting the prices, and who is responsible, should be final. After careful consideration of a price it should be put on the work *to stay,* the understanding with the man being that the price will not be changed, no matter what he may make, except for certain conditions which should be definitely and strongly set forth, such as changes of operation, jigs, and fixtures, or changes of design; something will be said later regarding this. The great evil of piece work is the cutting of prices, and it is along this line that piece-work systems need remodeling; for upon this depends the real success of the systems—not in the process of their working, perhaps, but in the final results.

If the price and details of operation on the contract just placed in the hands of the foreman meets with his approval, the contract is given to the man, who keeps it in a receptacle for that purpose near his work —if possible, convenient for the time clerk, unless the man keeps his own time (which he should not be allowed to do). From this contract card the time is made out on a suitable ticket and sent to the office, also the time clerk makes entry of the time upon the back of the contract card. In the office the time is entered upon the back of the duplicate contract card which was retained at the time the original was issued.

When the job is "turned in" the original contract and the duplicate must balance, thus acting as a check for mistakes and otherwise.

When the workman has completed the contract it is OK'd by the foreman or inspector, preferably by both. It is then turned over to the office, the amount of the man's day pay, which he of course has been receiving during the progress of the work, is deducted and the balance

Name	Geo Johnson			Pec. No.	T 80 K		
Division	Headstock	Job No.	1250	Cont.No.	8542		
Operation	Turning to finish after being roughed, cut in five bearings to grind, cut thread leave .008 to grind						
Day Rate	250	Pec. Rate	345	No. Mchs.	1	Mch. No.	207
No. Pecs.	25	Price	$2.00	Total	$50.00		
Com.	7 A.M. 3/17/03			Foreman's O.K.	F. T.		
Fin.	3 P.M.			Inspector's O.K.	R. J.		
Remarks	Stock in excellent condition						

	Contract	Day Pay	Balance
Amount	50 00	36 25	13 75
Hours			
Date			

Amount																36 25
Hours	10	10	10	10	9	10	10	10	10	10	9	10	10	10	7	145
Date	3/17	18	19	20	21	23	24	25	26	27	28	30	31	4/1	2	

FORM 4. RECEIPT CARD, SIGNED AND RETURNED BY THE WORKMAN IN EXCHANGE FOR THE AMOUNT CALLED FOR THEREON.

The back is used for date and name, a convenience in handling and filing.

T 80 K

Job No.	Prc.	RATE Day	RATE Piece	WORKMAN	No. of Pieces	No. of Machs.	Prem.	Machine
12 50	2 00	2 50	3 45	Geo Johnson	25	1	13 75	30" Lathe

Turning to finish after
being roughed, cut in five
bearings to grind, cut thread.

FORM 5. FILING ENVELOPE; 3⅛ BY 5½ INCHES, STRONG WHITE MATERIAL OF HARD SURFACE.

Front (upper figure) gives the consecutive history of the operation; the back (lower figure) gives the details.

made payable to him. When he receives this balance he gives his receipt, as shown in Form 4. This receipt is very important, as it settles all future question as to whether a contract has been paid for or not.

After the contract has completed its active usefulness it is returned to the clerk who issued it, to be placed in a filing envelope and filed in a suitable cabinet as a permanent record for future reference. Form 5 shows the filing envelope, upon the face of which is the information necessary for the clerk who makes out the contracts. The envelopes are numbered with the operation symbol or abbreviation, the consecutive piece number, and the machine symbol, and filed according to the piece number. Each operation takes a separate envelope upon which entry is made when the contract is given out. This envelope will give the correct history of the operation on a piece, showing the changes or advances made, or its cost from time to time and the reasons therefor; the back of the envelope should show the details of operation. Here let it be emphasized that it is very essential for the details of each operation to appear upon the envelope, even if trivial, and they should appear also upon the contract which goes to the man. The files which are made up of these envelopes must be in a compact form, to be immediately at hand so the person in charge will not be obliged even to leave his seat to obtain the desired information, for this person will be one who will have to count his minutes. For each operation the process is carried through as was the forging, until the piece has been completed and in place on the machine. The illustrations here shown are for the turning operation.

Under this system two men and a messenger can take care of 25,000 contracts during a year, with all of their mass of detail. This does not of course include the time or shop order systems.

Neither this system nor any other can be a success unless there is co-operation on the part of each individual who comes in contact with it. If it overloads the foreman with work, the work will not be done; if it causes continued distrust or suspicion on the part of the men, then it will have the same effect as any system which holds out rosy inducements that never can be realized. A person intuitively recognizes justice; if he does not openly he will by his action and conduct, provided that he is one who will grant it in return. Are there not a few in your factory concerning whom you feel that if anything goes wrong with their work it is not because of carelessness nor neglect on their part? And in turn do they not take what is done on your part as done in good faith? Yet there is not necessarily satisfaction on either side, but there is a tacit recognition of justice on the part of both. On the other hand, are there not some whom you feel are holding back and are careless (in some cases deliberately so) and who regard what is offered them as only a means to grind them down or squeeze more work from them? Here there is mutual recognition of injustice. While it is true that this condition will exist as long as human nature remains as it is and cannot be done away with or remedied, yet it can be alleviated.

The average man who receives justice hesitates long before he makes unreasonable demands or trouble. The source of his work and the cause of considerable of his conduct lies with his employer. Then it is for the employer to take the initiative in the extension of justice in his own shop. If he deals out what he honestly considers justice, without watching to see the effect of each spoonful administered and looking for some demonstration, he will not hastily throw up a system which deals justice because he does not see results after the first dose. It would not be inferred that any thing but justice had previously or would subsquently be intended, but each feels that the other has a reserve and he in turn must have one with which to meet it; the consequence is a deadlock or the administration of force on either side, or perhaps underhandedness on the part of the man. By underhandedness is meant that if a piece of work can be done in six hours and a man takes ten to do it, conducting his work so that his foreman will think he is working hard (and perhaps he is in his endeavor not to), doing so on the plea that he is doing it in his own defense, he is underhanded, although he does not intend his action to be so. Its offset is to force that man to do the work in less time when it is discovered that he is delaying the work—provided it ever is discovered. How much less time it should be done in is very difficult to determine under these conditions, as the man will not help. Then follows a continual antagonism between the man and his employer which leads to every sort of trouble. Because of that result it would never be discovered what a man could really do until the cause had been removed or relieved and his confidence established. This can be accomplished only by giving him a real article. If he is to help the business let the business help him, and help him first.

Now a word somewhat aside yet bearing upon the subject. One of the sources of mutual benefits is shop improvement. It is a sort of axiom that only foremen and heads of shop departments with drafting rooms make new jigs, fixtures, new operations, or other improvements. It is taken for granted that a workman, no matter what his capacity, will do the same old job in the same old way until instructed differently, even if he knows a better way. Under some foremen a suggestion would be considered impertinence, yet there are a great many dollars locked in the hearts and minds of the workman that should be open for the mutual benefit of employer and employee. How they are to be gotten at is a problem of the day. It certainly can not be done by offering a bait to catch them, as a fisherman would so many fish, to be taken from the hook and used for his own purposes. In this case the fish has something to say. It can be done only by an honest, business-like exchange of benefits, permanent benefits both to employer and employee. If men have been suspicious with or without cause, it will be an uphill fight to establish confidence in its place. Infinite patience must be used and a rigid holding to a strict line of justice—liberal justice, if perhaps it might be so expressed. The confidence of the men must be had to make any system succeed, but success does not mean a policy that will cause no controversies or differences of opinion, for it is of course possible to have a system which runs smoothly but accomplishes very little. Instead of running smoothly in such a manner, this system properly carried out will give rise to numerous troublesome questions which might otherwise be buried, but ougth not to be. To illustrate: suppose a $2.50 man is given a price of $3.00, and understands that the company reserves the right to cut if he makes above a certain amount, definite or indefinite, say $3.00 per day. Then he will make $3.00, or less, and if an accident does not reveal that his job can be done in less time, he will deliberately continue in that rut for years, perhaps, while the company congratulates itself that it has a system which is running smoothly. Presume this same man to have the price of $3.00 for that same work, given as a fixed price (barring conditions mentioned) ; if his confidence is established, and he *can* do it in six hours, he will do so and reap the benefit. This man will do all in his power to reduce the time by making the minutes count, possibly suggesting a jig or fixture, or change in design of that piece to expedite his work. This policy will serve also to bring up and to answer questions which would otherwise be overlooked, as for example whether one machine is faster or slower than another, or whether the belt may need tightening, or the countershaft speeding up, etc. I have known men to turn shafting of small diameter with numerous shoulders and similar work, all day, at speeds varying from 100 to 150 feet and to do good work, when their neighbors did not have the nerve to handle this work and turn out a good job at 80 or 90 feet—the best they could do. If the man who could run at the higher speeds had been afraid that his price would be cut so that he could make only $3.00 per day, then instead of the company having the benefit of that speed and himself making between $7.00 and $8.00 per day, he also would have used a speed of 80 or 90 feet, both the company and himself losing. The man would have protected his price and his fellow workmen who could not work at the same speed.

There are honest differences between the quantity and quality of work which different men can turn out, and these differences must be recognized. If in the above mentioned case, of the man who made $7.00 per day (an extreme case, by the way,) the price had been cut so he could make $4.00 per day, which would be excellent pay, then the next man to get the job would not be able to make his day's pay unless the price was changed for the slower man, which of course would never do. If the first man again got the job at the cut price he would not put forth the same effort on this or on other jobs for less money, when he felt that he must do more work for it. Added to this is his uncertainty of knowing how much lower the price is going. Just or unjust as this may be, the result will be the same—the curtailing of production, which is the thing to be avoided. Let us look at this same case in another light. If the company consider the work on this piece to be worth $3.00 to them, accepting ten hours as a reasonable length of time for the completion of each piece, then the cost to produce that piece would be $3.00 plus ten hours' hourly burden of say 25 cents per hour, making the cost of production $5.50. The company have what they consider a fair equivalent in the increase of production and the decrease in the cost of the production of that piece. If more than ten hours are taken the cost of producing that piece increases accordingly. On the other hand, if the man by his own effort or contrivance can do a good job in four hours (taking an extreme case) then the figures would stand as follows: price per piece, $3.00, plus four hours' hourly burden, making the total cost $4.00. The company gain the increase in production and $1.50. The man gains all that he has put out his effort for, a confidence in the company's willingness to pay for what they get, and $2.00 on each piece.

Can a company afford to increase their own costs and put a restraint upon their just output by jealously watching the amount of money paid into their workmen's hands, without considering what they have received in return? It would be a parallel case for a concern to buy pencils for the office a dozen each day at 50 cents rather than pay $30 at once and receive a hundred dozen with the discount. If the 50 cents is compared with the $30 without other consideration, then 50 cents is certainly less than $30 to pay for pencils. A ridiculous comparison, some one says; but that is the way piece work or other systems are often looked at. That is, it might be said to a workman: "You may have $3.00 each for these two pieces if you take two days to do them in, but if you do them in one day this company cannot afford to pay you $6.00 per day, so you will have to do them for $1.50 each." That is exactly the proposition made to a man when the unconditional right is reserved to cut the price which is given to him. Will that man be apt to do two per day unless forced to do so? Is it a business proposition? Where would be the object for a man to exert his wits and his muscles to their utmost when he knows that he will receive no more in the end than if he had taken the full amount of time allowed? He feels that he is making money without compensation for a stranger (for that is what his employer is as far as any sentiment is concerned, with some exceptions) and he will ask you "if that is not the fundamental principle of slavery?"

We have one case of a piece-work job being done for years under the old-style system, 108 hours being the lowest record and extending from this up to 120 hours. Upon agreement with this man that his price would not be cut, no matter what he made, the time was reduced to 78 hours on the next job.

By the foregoing I would not infer that the first estimate for a price must be the fixed rate. That would be risking too much to misjudgment and mistakes which the most expert estimator is liable to. A contract can be issued upon a card of a special color, say blue. Any contract issued with this color should be understood as not necessarily being a fixed price; then let the job be followed by a trustworthy and competent person (this does not mean that a person must stand over the workman with a watch in his hand) and the speeds, feeds, and methods observed. This can be done several times if absolutely necessary, but not unless it is absolutely necessary, as it is a delicate proceeding not to give offense, and the one doing it should be the person least objectionable to the man, preferably the foreman if his duties will permit. With all precautions some mistakes may be made, but they will more than be recompensed by the general result. When the price is once fixed it may go out on a card of another standard color, to be recognized as fixed. Prices should be graded from the lowest to the highest priced man who will have occasion to do the work.

Having spoken previously of the right which the company should reserve, to reduce the price for jigs, fixtures, etc., and also of the rights of the man to be allowed the benefit in his price of these same things of which he is the originator, it will require a little additional information regarding an important part of this system to do away with any ambiguity which may be apparent. The man should be guaranteed that any benefit from any improvement introduced by him on a certain piece of work will be his without a cut as long as he does the work. He also should be given that piece of work to do as far as practicable whenever it comes along; then that man should feel compensated for his efforts. When the same work is given to another the price should be adjusted to meet the changed conditions, as likewise when improvements are introduced by the shop management. Any suggestion a man has to make should go directly to the shop management and not through intermediate hands. The management can so arrange that there will be no obstacle in the way of a man making suggestions. That would mean a flood of worthless ideas, if interest were taken, which would give rise to a number of troublesome problems requiring much tact and patience; but if properly managed, capable men should be made to take more interest in their work when they feel that the management will respect them for their brains as well as for the quantity and quality of the work turned out. There are, however, a number of workmen, harsh as it may sound, in whom no personal interest could ever be aroused by any means. Like the poor, they are always with us and they must be accepted as a social condition. If, however, only 10 per cent. of the workmen in a shop could be made to feel this personal interest in their work, it would be a great success. I have known three men of this sort to change the general character of a department of thirty men.

As obtaining the object desired would depend upon the confidence the men had in the system, by no act should they be made to think it a scheme or a bait. Sometimes a long period is necessary to establish confidence in the face of suspicion, as they will keep a watchful eye upon every detail of any attempt to place a system, especially if it offers unusual privileges. Any small thing, however unintentional it may be, which has a "trappy" shade to it will cause distrust. It is better to err on the side of generosity than to risk the creation of that feeling.

These ideas incorporated into a shop system will not set every man to working like a dray horse, nor will it make each workman hold exactly the same interest in the general success of the business as the proprietor; but the larger proportion of the men feel an interest in what yields them a personal compensation. The human factor will not admit of any other condition, and that human factor is what the present-day system must be built upon. The future may have something better in store, but the future will take care of itself.

STORAGE BATTERIES ON ELECTRIC RAILWAYS.

By Howard S. Knowlton.

THE growth of applied electricity has created many new industries in the last generation, which have given employment to thousands of workers. Some of these fields of opportunity are cultivated on the ruins of occupations now discarded by the civilized world; others flourish by entirely new applications of human skill and intelligence, called into being by discoveries which have no counterpart in the past. Thus the manufacture of electric motors has turned horse-car driving into a lost art, while the production of storage batteries displaces no handicraft, trade or profession from its position in the structure of modern industrial life.

Storage batteries are utilized in almost countless ways by the progressive engineer of today. Their value in telephone and telegraph practice, railway and fire-alarm signalling, yacht lighting, surgery, dentistry, radiography, isolated plant, laboratory, central-station and electric-railway work, has been thoroughly demonstrated by long experience. While their usual function is to act as reservoirs of electrical energy which can be drawn upon for the supply of current in time of need, they have many other uses which render them valuable to the operator of electrical apparatus. Especially is this true in the case of street and interurban railways.

The storage of working power or energy is everywhere evident to the observer of natural laws and processes. He sees it in the rain cloud, whose tiny drops fall to the earth and strike their infinitesimal share of the mighty blow with which millions of drops overturn a house or bridge in a flood. He notes it in the lump of coal, charged with the solar energy of ages, in the ponderous drifting iceberg, in the coiled watch spring, the raised hammer, and the revolving engine flywheel. It is almost impossible to name any operation of physical laws which is not based upon the storage of energy.

Electric railways are noted for the enormous momentary demands for power which their generating stations sustain. Generally the ratio of this instantaneous power output to the average load or power demand is much greater on a small system than in the case of a large one. The causes of these fluctuations are found in the constant starting and stopping of cars, changes in speeds, grades, curves, conditions of track and roadbed, and to some extent, the varying numbers of passengers carried. Far less power is required to run a heavy car at a speed of thirty or forty miles per hour on the level than to accelerate it to such a speed in starting from a standstill. A twenty-ton car making forty miles per hour may require sixty horse power or about forty-five kilowatts at the trolley wire, whereas in getting up to speed after a stop or slow down it may easily take two hundred and fifty horse power or one hundred and eighty-six kilowatts from the wire. Each car on a street railway may easily draw from three to six times its normal average current from the power station when accelerating, but fortunately on systems of large or even very moderate size, all the cars do not accelerate at the same time. However, the fluctuations in the demands for power are severe on all but the largest roads, with present types of railway motors and methods of controlling speed. The electric railway thus offers an attractive field for energy storage, in order to avoid the installation of current-generating machinery and transmission apparatus whose supplying capacity is greatly in excess of the average demands of the cars. Here the storage battery rises to the occasion, and, when financial conditions are favorable, it absorbs and gives out energy with signal success, in the operation of the system.

The popular impression is to the effect that such a battery stores up electricity, and that the bottled-up fluid is held somehow under pressure, to be released on demand like highly charged mineral water. The principle of the storage battery is quite different from this, as the entire action is chemical, fundamentally.

The storage battery is a simple piece of apparatus, mechanically. In its most familiar form it consists of two lead plates supporting active materials, a high oxide of lead for the positive plate, and metallic lead in a spongy, finely divided state for the negative. The plates are immersed in dilute sulphuric acid and contained in a glass jar or wooden tank lined with lead. Two plates, one positive and the other negative, constitute a couple, and a cell may be made up of as many couples connected in parallel as the requirements of discharge necessitate. That is, all the positive plates are connected together separately from the negative plates, which are themselves joined in one aggregation independent of the positives. A battery consists of a considerable number of cells connected usually in series—that is, the positive group of couples in each cell is joined to the negative group of the preceding cell, so that the electric current passes through all the cells, seriatim. Since each cell gives a voltage or electric pressure averaging about 2.08 volts during its discharge, in railway work, we require two hundred eighty-eight cells in a battery which is to operate on a 600-volt trolley system.

Now, "charging" a storage battery simply means passing a continuous electric current through it from some outside source of supply, as a railway or lighting gentrator, and thereby causing certain chemical actions to take place. The energy of the current is thus stored up as chemical changes and recombinations, or in other words it is transformed into potential chemical energy.

"Discharging" a battery is naturally the reverse of the process just indicated. The battery is connected to a railway, lighting, or general power circuit, and it at once begins to deliver current, generated by the reversed chemical actions which begin to take place as soon as opportunity is given for a current to flow. Back goes the battery towards its original uncharged condition, and the cycle may be repeated over and over again, always with the same resulting chemical actions caused by, and then causing, the electric current. At each discharge there is an exceedingly slight deterioration of the active material on the positive plates, so that in a few years, more or less, these plates must be renewed, and are said to be "worn out." It is unnecessary to charge or discharge a battery entirely before reversing the process, and it may be drawn upon for electrical energy within the limits of its capacity just as freely as one would draw water from a reservoir. The voltage of a fully charged cell is about 2.6 volts maximum, and this is allowed to drop to about 1.8 volts per cell in discharge. The voltage of a battery thus is indicative of its condition with reference to being charged, as is the specific gravity of the acid and water, or so-called electrolyte, which varies from about 1175 at discharged to 1210 at the charged state.

Primarily, then, the storage battery applied to electric railway systems holds its position through its ability to absorb the violent fluctuations in current demand which would otherwise be thrown upon the generating apparatus and transmission system. Through its power to charge or discharge at any point within its working range, the battery absorbs energy at times when the demand for it is light, and gives it out when the severe momentary pulls of the cars would impose a tremendous burden upon the power stations, sub-stations and distributing circuits. It acts like an elastic spring in taking up the shocks which arise from the sudden calls for power.

The use of batteries mounted directly on electric cars is practised but little in the United States. The great weight of the lead constructed cells militates severely against successful competition with the overhead-trolley system, the underground trolley, or the third rail. Batteries are, of course, in successful operation in automobile and light vehicle work, with some application to factory yard locomotives, but their present growing adoption by electric railways is almost without exception in the form of "station" or "line" service.

A storage battery in a railway power station relieves the generators and engines of violent fluctuations in load, and by charging at periods of light demand, it gives the generating machinery in many instances a steady load to work upon. This means better economy in operation and a reduction in fuel and water expenses which often more than pays interest and depreciation charges on the battery. It is well-known that electrical and steam machinery offers comparatively poor economy when underworked, and the battery goes a long way toward eliminating this troublesome feature. A great advantage of the battery is its ability to supply power during the night, or at times of sudden breakdown of the generators, engines, of boilers. This was well illustrated in a recent experience of the International Traction Company of Buffalo, which was heavily crippled for power when lightning burned out some of the transformer apparatus of the Niagara Falls Power Company, and shut down the industrial plants and railway systems for miles around. By the use of its storage batteries, the railway company was able to operate many more cars than its steam stations could handle.

Such a battery requires no attendance at night, and when charged, is available for power twenty-four hours per day, in conjunction with the regular generating machinery. Having no moving parts, it can be left by itself many hours at a time, with no fear of anything going wrong. Its value as a reserve in case of emergency is thus very great, on roads where the traffic is considerable. Its first cost, on the basis of its highest discharge rate, is about the same as that of an equal capacity of steam and electrical generating machinery. Batteries are often called the "watch dogs of the system" because of the readiness with which they take up the work of current supply the moment the other machinery gives out or is overworked. The battery is always located in a room separate from other apparatus, as it is necessary to isolate the gases which rise from the cells, and which are harmful to copper, iron, and practically all commercial metals except lead. The cells are set up in rows mounted on insulators, which in turn usually rest on stout timbers. The connections are made by lead bars, or by copper bars covered with asphaltum or some acid-proof material.

When power is transmitted from the generating plant to sub-stations for local distribution, the battery occupies a similar useful position in connection with the sub-station machinery, with the added advantage of reducing the cost of transmission and transforming apparatus to the level of simply providing for the average power demand. Here, as in the main station, the battery takes up the load fluctuations, and gives the generating and transforming machinery a steady work to do. An example of a station battery may be quoted in the practice of the Seattle (Wash.) Electric Company, which has recently installed 278 cells of the "chloride accumulator" type in its Post Street plant. This battery is capable of discharging at the rate of 880 amperes for one hour at 575 volts, and thus has a maximum output of about 510 kilowatts, or 685 horse power. It weighs about 135 tons, exclusive of its supports.

The other great use for storage batteries in electric-railway work is on the line, at a considerable distance from power house or sub-station. Efficient service by the cars depends mainly upon their receiving current at the highest feasible pressure or voltage. The drop in line pressure as one recedes from the power house is often a very serious matter, and as the speed of the car motors at three hundred volts is about half the speed at six hundred, it is evidently of the highest importance to maintain as high a voltage as is possible all along the distant line, from the power station to the car farthest away from it.

This can be done in several ways, the two most common being to put up heavier feed wire and thus add more copper conducting power to the system, or to install a storage battery out on the line, with the addition of little or no copper, and sometimes the removal of a portion of the wire already in service. The choice between the copper and the battery is always a problem in dollars and cents, as is the selection of a battery for station service, both demanding a skilled knowledge of electrical finance.

A line battery is usually installed in a car house or some inexpensive building devoted to its shelter, and it does its work with very little attention. If it is connected directly across the line between trolley wire and track it is called a "floating" battery, and its operation is very simple. When the cars running on that section of the road take little power, the distant power station charges the battery, and then, when heavy drafts of power are made by the cars, the battery discharges, and by reason of its nearness to the cars, holds up the line pressure and relieves the power station from excessive fluctuations. Of course, a battery cannot itself generate any energy, but must receive all its working power from the power station itself. When such a battery is installed near a heavy grade its assistance to the cars is still more marked, and in some cases it would be impossible for the schedule to be maintained if no battery were in service, without a prohibitive money outlay for copper feeders. The same advantages as to reserve power, all-night current available, etc., apply as well to a line battery as to one set up in a power station. Sometimes it is necessary to charge such a battery through a "booster" located at the power house, instead of letting it "float" upon the line continuously. The "booster" is a small generator driven by an electric motor or steam engine, and its function is to apply a higher voltage to the battery than could be obtained by simple feeders connected with the power-house machinery. Thus, the voltage of the generators in the station may be 600, but the line drop calls for a "boost" in this electric pressure of say 250 volts, in charging the battery. Boosters are also generally used to regulate automatically the charge and discharge of station batteries in connection with the generating machinery. An interesting example of a line battery is found at Long Beach, Maine, on the road from Kittery to York Beach. Here the Portsmouth, Kittery, and York Street Railway Company have installed a battery of 220 cells, capable of discharging 160 amperes current for one hour at about 460 volts. It is of course capable of discharging at a slower rate for a longer time. The main power house of the company is located at Kittery Point, some ten to twelve miles away, and the battery is thus of great use in helping to carry the heavy summer traffic which this famous scenic route creates. The battery is tucked away out of sight in the basement of a car barn, and the only sign of its presence on the outside is a tell-tale feed wire which runs into the building.

Another interesting recent application of the storage battery to street and interurban-railway practice is found in one of the newly developed train-control systems now on the market. The operation of switches throughout a car or train for the control of motor speeds is set in motion by small electrically opened valves supplied with current from a 14-volt battery. This is naturally a small affair compared with the types which we have just been considering, and has but a limited use so far. Mention might also be made of the use of batteries in train lighting, but as this applies almost entirely to steam railroads, it falls without the scope of this article.

The future of the railway storage battery is difficult to predict, at present. If the progress of science develops a form of battery which is far lighter, and somewhat more efficient than modern types, there is no doubt that a revolution will be worked in methods of applying electricity to railway service. It would be a wonderful step forward to sweep away with one brilliant stroke of invention or discovery all the present complicated and expensive transmitting wires, transforming and distributing devices, which render an electric-railway system a labyrinth of intricacy at best. The marvellous triumphs in the study and manufacture of high powered explosives lead us to hope that some day electrical energy may be sold freely in concentrated battery cartridges, and applied to the propulsion of trains with an efficiency hitherto undreamed. Certain it is that the present applications of batteries to electric railway work will find a constantly increasing field of usefulness, as long as continuous-current motors are employed in driving cars, and with many able inventive minds bent upon the battery problem, there is at least ground for hope that a brilliant future may sometime be realized in the scientific storage of electrical energy.

LIQUID FUEL FOR POWER PURPOSES.

By Arthur L. Williston.

Professor Williston's opening paragraphs summarize briefly his preceding article, and the paper following completes the treatment of the question of the use of oil fuel from the economic side. With his study of the mechanical elements of the problem in our May issue, this forms a comprehensive and most valuable discussion of a new departure in power-plant engineering, in which there have been heretofore available only scanty and somewhat vague data. The importance of the subject lies in the possibilities of mechanical and industrial expansion which are opened by the successful burning of liquid fuel under the steam boiler. —THE EDITORS.

IN the preceding issue of the Magazine data were given regarding the heating values and boiler efficiencies that had been obtained by experiment with different fuel oils and steam coals; and we discussed the direct influence of liquid fuel upon the charges for fuel, firing, and repairs, and the conditions under which its use will result in reducing the annual operating expenses of the plant. But the influence of its use on the design and first cost of the power plant was left for the present article. It was shown that one pound of oil was equivalent to from 1.5 to 3 pounds of coal, according to the quality of the latter, and that a slightly higher efficiency—perhaps from 4 to 6 per cent.—might usually be expected from the oil; while the boiler capacity, or evaporation per square foot of heating surface, with it, might be increased from 30 to 50 per cent., without lowering the efficiency. The saving in the cost of firing, it appeared, would vary from little or nothing in very small plants to perhaps 75 per cent. in the largest, being equivalent to a reduction of 20 cents per ton of coal burned to produce an equal horse power, in the example which was chosen for illustration. The corresponding saving in cost in absence of ashes to be removed is 18 cents; but to offset these figures partly, it was found, were the two items of the cost of the steam for the burners —about 14 cents on the average—and 5 cents for additional repairs needed to keep the boiler settings tight and free from cracks when oil is burned. All of these figures have been reduced for comparison to a common basis by dividing the total amounts by the numbers of tons of coal burned when coal is used as the fuel.

Now let us consider the second phase of our subject—the indirect influence of the use of liquid fuel through alterations in the power-plant design causing a reduction in its initial cost, and a corresponding reduction in the annual fixed charges. This, of course, will apply only to those plants where it may fairly be assumed that a sufficient supply of fuel oil will be available, at a price which will make its use profitable, for a sufficient length of time to warrant our designing the plant to give the maximum economy when burning oil, rather than governing the design by those conditions which experience has proven to be the best practice when coal is used as the fuel. Oil burning for power purposes, on a large scale, is too new, and the experience is too short, for any large amount of accurate data to have been accumulated, consequently in discussing this part of the subject, I cannot make exact estimates. Nevertheless, experience has already definitely shown certain things that materially alter the design of the boiler plant where the permanent use of liquid fuel is contemplated. Two of the most important of these influences for us to consider here are:

First.—The increased rate of combustion with liquid fuel, which means an increased capacity for a boiler of given size, with greater, or with substantially the same, efficiency. As a result of this, it will be possible to obtain a given output with a plant of smaller size and first cost than would be considered good practice with coal under natural draught. The conditions will approach more nearly the practice with coal burned under a forced draught. This advantage of liquid fuel is particularly great where the steam consumption is liable to sudden fluctuations for comparatively short periods.

Second.—As has already been shown, oil may be burned with materially less draught pressure than is required for coal. This may affect the design of the boiler plant in two ways—it may mean that a smaller and less expensive chimney will be required, or it may mean that a considerable amount of additional heat can be advantageously abstracted from the flue gases by means of economizers, lowering their temperature to one materially below that necessary to maintain the proper draught pressure if coal were used. This will, of course, give a corresponding increase in both the capacity and the efficiency to the boiler plant.

The effect of these two influences upon first cost and annual charges can be judged from the following illustrations:

Suppose a boiler plant to furnish power for a lighting station which will require, during the period of heavy loads, 2,400 boiler horse power, but which, during the greater part of the twenty-four hours, would require considerably less than 2,000 horse power. If this load fluctuates rapidly and, at times, is likely to exceed the 2,400-horse-power limit, it would be unwise to have, for regular service when burning coal, less than twelve 200-horse-power boilers. On the other hand, if the plant were designed entirely with reference to burning oil, the possibility of forcing the fires would make it safe to rely on perhaps but nine boilers of the same size. The same percentage of reduction in the capacity of any reserve boilers to be used in case of breakdowns or repairs could also be made. This reduction will affect not only the boilers but also nearly all the boiler accessories and the cost of the boiler house as well. We could. therefore, in this case, figure on a reduction in the initial cost of the plant of 25 per cent., with a corresponding reduction in insurance, taxes, depreciation, and repairs. Estimating the cost of such a steam plant at $32 per boiler horse power, the total saving would be $16,000.

It is fair to assume the following as an average for the fixed charges of a good steam boiler plant:

Interest	5	per cent.
Taxes and insurance	1½	" "
Depreciation and repairs	4	" "
Total	10½	" "

This would give a reduction in the annual fixed charges equal to 10½ per cent. of $16,000, which would be an annual saving of $1,680. In order that we may judge the effect that this will have on the comparative cost of coal and oil, we shall assume that our boiler plant, if it uses coal, will in the course of a year use 14,000 tons; the saving in the annual fixed charges would then amount to 12 cents per ton. There are at the present time, perhaps, comparatively few boiler plants where it would be wise to count on having a permanent supply of cheap fuel oil, but if the plant in the above illustration were not new but were contemplating an increase in its capacity which would be rendered unnecessary by the introduction of oil-burning appliances and the use of liquid fuel, it would be proper to credit to the oil the same saving.

The reduction in the draught pressure which is required for oil might affect the steam plant which we are considering in three different ways: first, if we keep the same draught pressure which would be necessary if coal were the fuel used, the design of the boilers may be so modified as to give a very much larger number of flues of smaller cross sections; or in case of water-tube boilers, a larger number of tubes in the same area; thus, in both cases, increasing the heating surface, efficiency, and capacity of the boiler; or second, if the design of the boiler is kept in accordance with present practice, it will be possible to reduce the height of the chimney 30 per cent. to 40 per cent., reducing its cost in a still greater ratio; this, however, in most cases would not reduce the total annual expense by more than 1 per cent. or 2 per cent.; or, third, as I have already suggested, the decreased draught pressure required with oil makes it possible by means of economizers placed between the boilers and the up-take, to lower the temperature of the escaping gases, to a point far below the temperature that would be required to maintain the draught needed in order to burn coal. In this way, both the efficiency and the capacity of the plant may be increased, and experience has shown that a saving of from 10 to 15 per cent. may usually be expected. The chief objection to the economizers, too—the difficulty of keeping them clean and free from soot and ashes—is removed in the present instance with the liquid fuel.

These amounts—12 cents for reduced fixed charges and perhaps from 25 to 35 cents for the saving due to economizers—should be included in the calculations of the relative cost of coal and oil for fuel in the cases to which they properly apply. They would not materially alter the final result in such extreme cases as the examples chosen for illustration in the previous article, where it was found that for New York city the use of oil will increase the cost of fuel 69 per cent., and for California, New Orleans, and Texas, that it might reduce it by an equal amount. In other cases, however, where the comparative cost of the two fuels is nearly the same, it is important that these items be carefully considered when plans are being prepared for power plants of magnitude. In certain cases where there would be no direct saving in the cost of fuel from the use of oil, there might, it is apparent, nevertheless be because of its influence on the design of the plant, a real saving amounting to as much as 40 or 50 cents per ton in the price of coal. There are certain other cases, too, in which there might be no real saving—perhaps even an increase—in expense, and yet where it would still sometimes pay to use liquid fuel. I refer to locomotives, especially for passenger and heavy or fast freight service, and to the merchant marine and the naval service. The space will permit me to refer only most briefly to a few of the reasons in each case which might make the use of oil advisable aside from any relative saving that might be derived from its use as compared with coal. The locomotive has already nearly reached the limit of its possible capacity because of its limited boiler capacity, yet the demand for greater boiler power for both fast passenger trains and heavy freight service still continues to increase. The help that oil can give to the solution of this problem by increasing the boiler capacities gives it a value entirely apart from its value in a stationary plant. Other reasons are its ability to respond quickly to sudden loads; ease and time saved in starting and in extinguishing fires; freedom from sparks, cinders, smoke and ashes; and ease and time saved in loading. The increasing demand for prompt certain, and cleanly service on our railroads make these advantages of fuel oil have great weight. For the merchant marine service all of these conditions which favor the use of oil on the locomotive equally apply, with the additional advantage of the economy of fuel storage space, allowing more room for paying cargo. For naval use, the military advantages may be even more important than the commercial advantages which are as great here as they are in the merchant marine. Freedom from smoke, and the extension of the steaming radius by permitting more fuel to be stored in the same space, are incalculable advantages; while a fuel that will increase the efficiency and the capacity of the boilers, or increase the speed with which full power may be obtained on short notice, increases the value of the whole battle-ship in almost as great a ratio.

The whole question of the economy of oil burning, however, ultimately turns upon the price of oil at the wells, and the available annual supply. Figure II shows the average yearly price of the Pennsylvania oil per barrel at the wells over a period of years from 1860 to 1901. It has fluctuated from a minimum price of 10 cents in December 1861 to a maximum price of $12.00 in July 1864; but as a rule the price has been fairly constant, decreasing on the whole as the production in the United States has increased. In a general way, the price of Pennsylvania oil controls the price of nearly all the other crude oils, and they fluctuate as it fluctuates, the relative price always remaining practically constant and depending on the relative values for refining. At the present time, with Pennsylvania oil selling in the neighborhood of $1.50 per barrel at the wells, Ohio and Indiana oils are worth only about $1.00 and 95 cents respectively. This is because of the sulphur in the latter oils, which makes the process of refining difficult, and also because of the smaller percentage of the light oils valuable for illuminating which they contain. The quality of the California crude oil varies very greatly according to the location of the wells, some of it being excellent for refining purposes and some of it being almost worthless and suitable only for fuel. The range of prices at the wells,

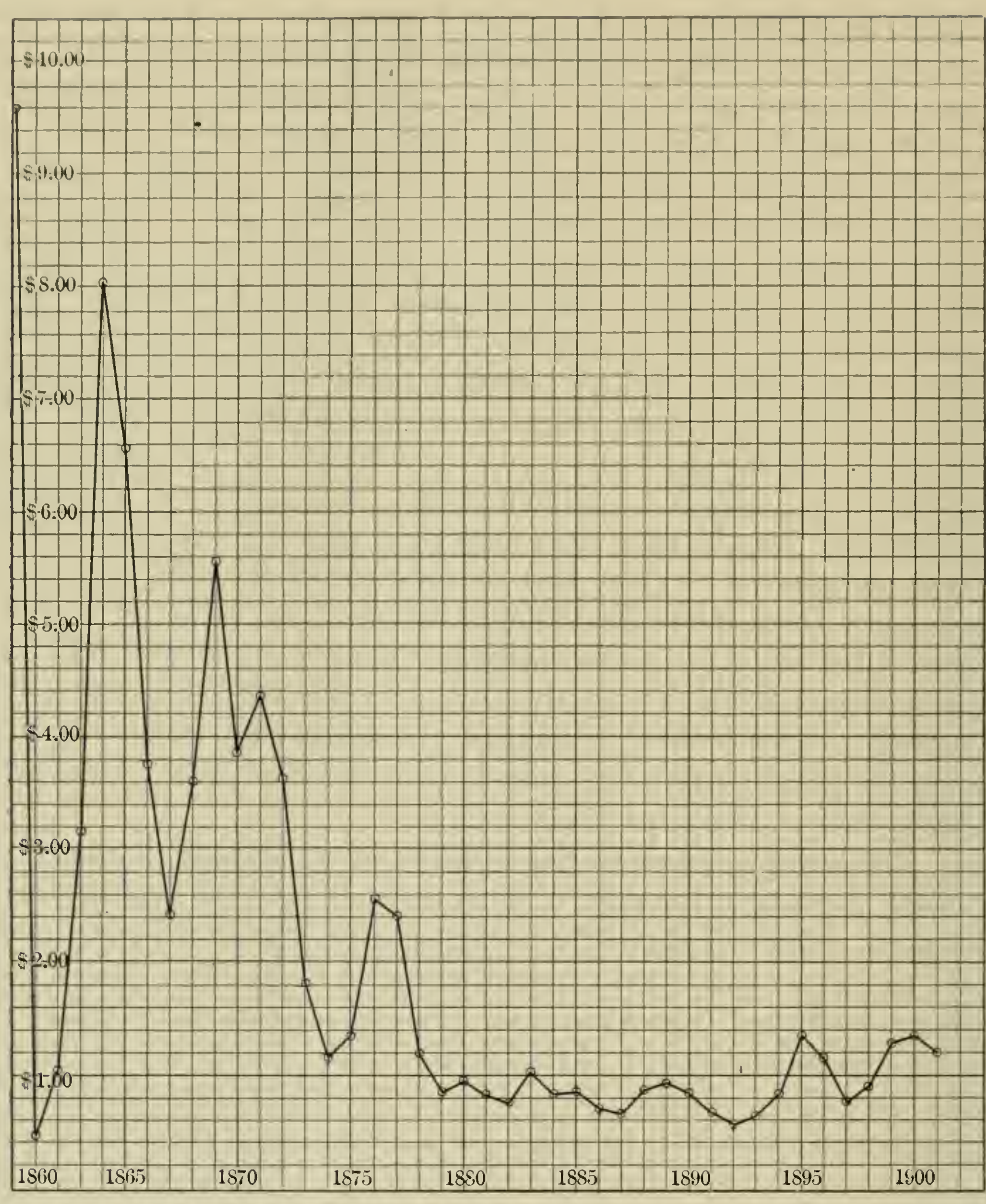


FIG. II. CHART SHOWING THE AVERAGE YEARLY PRICES OF PENNSYLVANIA CRUDE PETROLEUM AT THE WELLS FROM 1860 TO 1901.

therefore, is correspondingly great, varying from 20 or 25 cents per barrel to about $1.00, with a present average value of 55 cents at the wells. The value of Texas oil for refining is very little indeed, in fact, almost nothing. It contains little or no naphtha, which is the most valuable constituent in the Pennsylvania oil, and while it contains a reasonable percentage of kerosene, this is of somewhat uncertain character and produces an illuminating oil of an inferior grade. If its price were to depend on its refining value, it would be very low.

The supply of oil which is available for fuel, therefore, is, first, the small percentage (probably not over 2 per cent. or 3 per cent.) of the total production of the Pennsylvania and Ohio oil—the residuum from the process of refining; second, crude oil from the Ohio and Indiana fields, wherever the price of coal makes the burning of oil at 95 cents or $1.00 per barrel (plus freight) profitable; third, those portions of the California oil which are not best suitable for refining; fourth, practically the entire output of the Texas field.

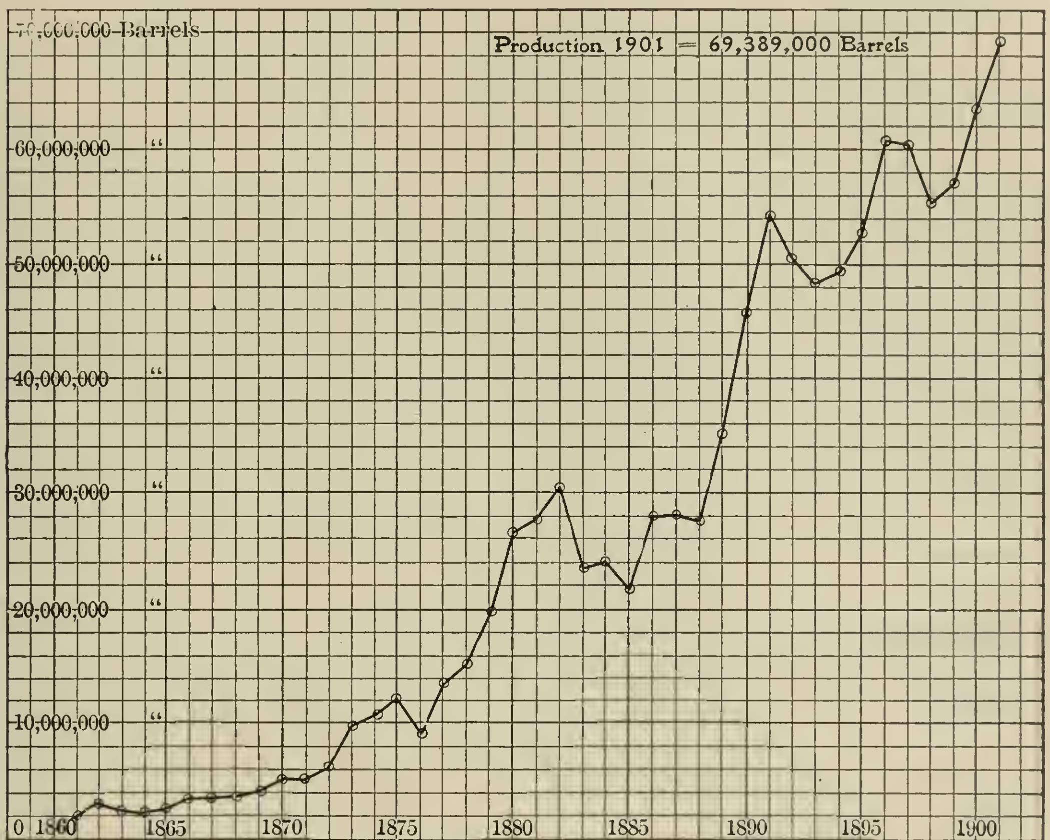


FIG. III. CHART SHOWING TOTAL PRODUCTION OF PETROLEUM IN THE UNITED STATES FOR EACH YEAR FROM 1860 TO 1901.

The demand for the better grades of oil for refining purposes will, probably, keep pace with its production; consequently we can never expect to see such grades of oil compete with coal to any large extent. On the other hand, the refining value of the Texas oil and much of the California oil is so low that its value will probably always be largely controlled by the demand for it for fuel purposes. It is inconceivable that a fuel which has so many distinct advantages and which is not unlimited in its supply should sell at a price which would make it cheaper to burn than coal in all markets. The great demand for it would bring its price up at once. On the other hand, the price of oil that has little value for refining will always remain low enough to enable it to compete advantageously with coal over a sufficiently wide area to create a demand for it that will equal its supply; and so long as there is an assured supply of Texas and California fuel oil in those regions where coal is especially scarce and poor in quality, it is improbable that its price will ever reach a point that will prevent its very extensive use for power.

At the present time the total production of petroleum in the United States is upwards of 70,000,000 barrels a year. Figure III shows how this production has increased year by year from 1859 to 1901, and

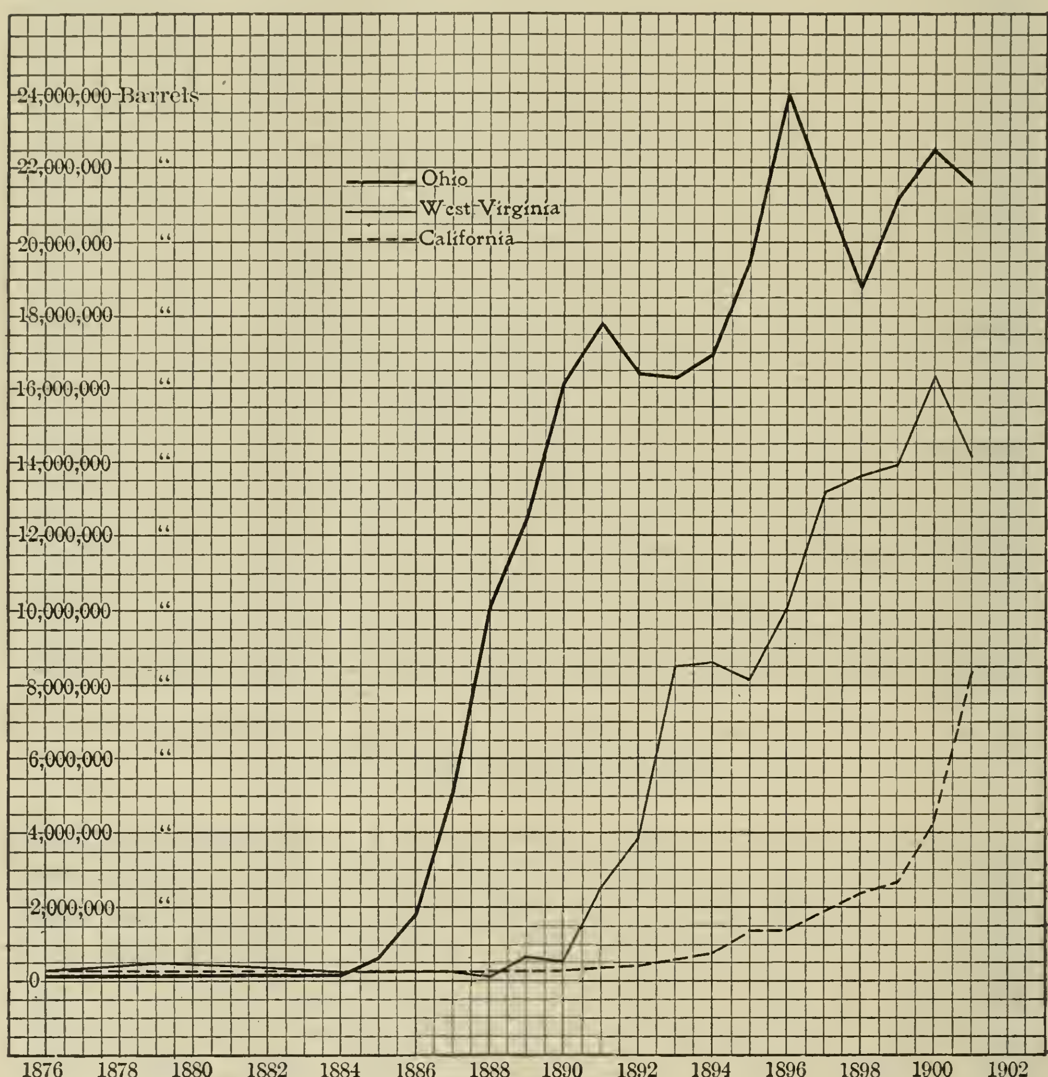


FIG. IV. CHART SHOWING THE ANNUAL PRODUCTION OF CRUDE PETROLEUM IN OHIO, WEST VIRGINIA, AND CALIFORNIA, FROM 1876 TO 1901.

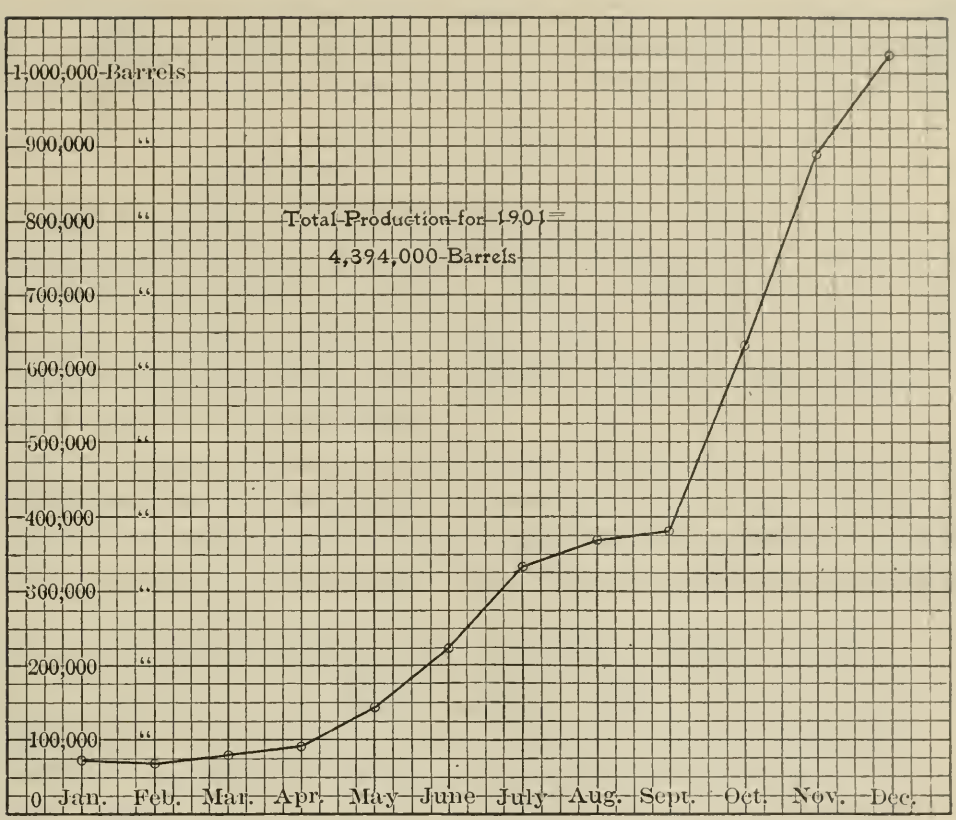


FIG. V. CHART SHOWING THE PRODUCTION OF TEXAS CRUDE PETROLEUM FOR EACH MONTH OF 1901.

(Barrels of 42 gallons.)

Table IV shows how the production of 1901 was distributed among the principal fields, and the average yearly price per barrel at the wells in each field.

TABLE IV.

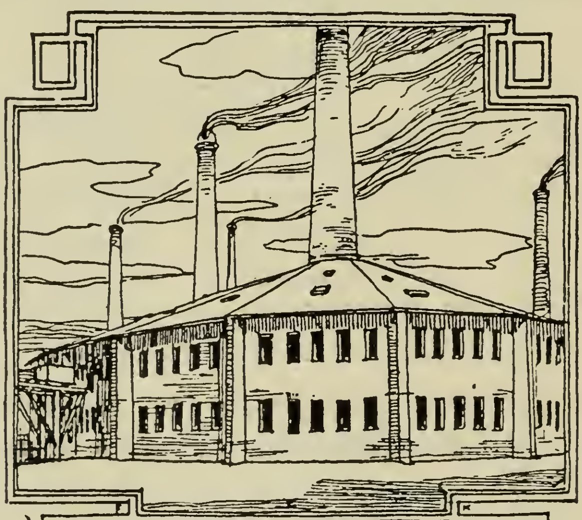
Field.	Production in 1901, Barrels.	Average Price.
Pennsylvania oil, Appalachian field...	33,618,000	$1.21
Ohio (Lima) and Indiana..........	21,648,000	.86
		.83
California	8,786,000	.56
Texas	4,393,000	.28
Miscellaneous	944,000	
Total	69,389,000	

It will be noticed that in 1901 more than 80 per cent. of this total was produced in the older fields of Pennsylvania and Ohio. Texas produced in 1901 but 4,393,000 barrels, a trifle over 6 per cent. of the total output of the United States. Figure V shows how this 4,393,-000 barrels was distributed over the months of the year. More than one-fourth of the total was produced in the last month. Accurate figures for 1902 are not yet available, but if the production in Texas for December 1901 remained constant for the twelve months of 1902 —allowing for no increase—it would correspond to a yearly output of over 14,000,000 barrels. Unofficial estimates place this total output for the Texas field for 1902 at over 20,000,000 barrels.

In this connection it is interesting to note the curves in Figure IV which show the growth and development of the oil industry in the Ohio, the West Virginia, and the California fields, from the time that they were first opened. Many wells have been exhausted, but in each one of these fields enough new ones have continually been opened to more than keep up the supply. It is possible that Texas will not follow their example, and it is always a dangerous hazard to make prophecy—especially in regard to oil wells—yet in the light of what knowledge we have, the following statement by Mr. F. H. Oliphant in the report of the Mineral Resources of the United States seems conservative:

> "In all reasonable probability there are other localities (in the Texas field) that are capable of producing wells of large production. It is probable that this section bordering on the Gulf will have its periods of depression following its present prosperity, which in time will be followed by the legitimate business of the production of petroleum. The final result seems to be assured that Texas will, in the course of time, be at the head of the list of the oil-producing States in this country."

If this last statement proves to be true—as the Texas field is the only oil field near the American seaboard—it means much for the future development of the use of liquid fuel for power purposes.



EDITORIAL COMMENT

THE controversy of eye-bar *versus* wire-cable construction for the Manhattan Bridge across the East River has fought its way through the correspondence and the editorial columns of many classes and grades of publications, and the drawn battle transferred to the aldermanic chamber rests its first stage with a temporary setback to the eye-bar project. The trouble about the whole affair is that the fight is being carried on in the wrong field, at the wrong time, and by the wrong contestants. No discourtesy is meant to the able and earnest engineers who have gone into the calculations, nor to the excellent journals which have published their discussions. But these very publications have emphasized the evident fact that the question is wholly one of economy, which can be determined only by the figures prepared, and offered as *bona fide* bids, by the leading competitors for the respective types of construction.

Taking into account the effect of pre-eminent facilities, there is practically only one concern that knows exactly how cheaply a wire-cable bridge can be built. There is practically only one other concern that knows exactly how cheaply an eye-bar-cable bridge can be built. The manifest advantage to the city is to leave the alternative open until the competition of the two plans has placed this knowledge at the public disposal. It is not likely to be attained if the city deliberately excludes either plan from the preliminary negotiations. The presumption may be against the economy of nickel-steel eye bars, but either scheme is good engineering. Either will make a good bridge. The retention of both under consideration until the costs have been figured by those who alone can figure them accurately, is good sense.

* * *

THE expression "His death is a great loss" has become so trite that it slips easily off the tongue and makes very little impression upon the imagination; but when used of the late George S. Morison in connection with the Isthmian Canal it seems to be suddenly invested with new and impressive meaning. Of all the members of the Commission, his study of the Panama route had been most closely specialized, most sustained, and most enthusiastic. He took a profound and beyond question a most thoroughly unselfish interest in the spreading of a clear understanding of the advantages of that route, and the reasons making its adoption and completion the only rational policy for the United States. Probably his last public communication on the subject was the article which appeared in our June number. Living, he would have made an energetic and invaluable member of the construction commission, to which we hoped he might have been appointed. But his work lives, and much of it was so far finished that the canal, when completed, will really be in considerable part a monument to his genius.

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THERE is, we believe, a very important industrial sequence suggested in the remark with which we preface Mr. Kershaw's leader in this issue—that trade-unionism in America is rapidly growing up to a strength relatively as great as it has already attained in Great Britain, and is patterning after the same policy. It means, if we are to believe the many able commentators who have discussed the reasons for the lately celebrated American ascendancy, that one of the important elements in that ascendancy will rapidly lose much of its impelling force. It is decidedly questionable, for example, if Mr. Orcutt were to rewrite the article on the "Development of Trade Under Competitive Conditions," which appeared as the fifth section of his study of "Machine-Shop Management in Europe and America" in our issue for May, 1899—it is decidedly questionable whether he could now be so confident that "the general spirit among American mechanics is to get the most out of a machine or tool, and to improve it if possible." It is very possible that he might now find, in many skilled trades in the United States, some of that same "tendency to make the job hold out" which he then remarked as the distinguishing characteristic of the European mechanic. And it is possible, further, that he might now wish to modify the characterization of the European worker as "indifferent, non-ambitious . . . a massive, inert stumbling block to progress"—at least, to the extent of excepting the new leaven of a very different temper which has appeared abroad since he wrote. And when we pass from the rank and file of the workers to the leaders, it is hardly open to question that British organized labor is led by men of higher type and wider vision than any but a very small minority of our American labor leaders. In fact, the careful study of the reports of the Mosely Industrial Commission from Great Britain, which recently visited the United States, would suggest that the disparity in the circumstances and capacities of the working classes, as between Britain and the States, is not so great as is commonly assumed, and that part at least of the difference of which so much has been made is due to what is frequently referred to in the Mosely reports—the recent "Expansive nature of American industry," due to the peculiar conditions of a new and rapidly filling country.

It will be most interesting to see these impressions tested by the renewal of a keen competitive struggle in foreign markets, when any slackening in home-trade activity again sends the American manufacturer abroad. He will find his foreign rivals far better equipped than in 1897—largely with weapons he himself has supplied. Has he made equal gains in industrial position during the same epoch ?

* * *

SELDOM, perhaps never before, has the distinction between the solid work of the engineer and the cloud castles of the promoter been so clearly marked out as in the phenomena presented by the present industrial and financial situation. The paper millions of Wall Street are blowing away into the thin air out of which they were called into brief and ghostly appearance by the lately great "leaders of finance"—and the real sub-structure of sound business and productive energy underlying is not even shaken by the financial storm. The industries of the country go on with scarcely a perceptible pause or slackening, while the "industrials" of Wall Street collapse upon their inflators. It is a striking demonstration of the distinction insisted on by Mr. George H. Hull, writing in these pages in August, 1900—the distinction between a financial panic and an industrial depression. And it is a suggestion that the retreat of the "Napoleons of Finance" has already begun.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

ENGINEERING CONFERENCES.

PRESIDENTIAL ADDRESS AT THE OPENING OF THE THIRD ENGINEERING CONFERENCE AT LONDON.

J. C. Hawkshaw—Institution of Civil Engineers.

AT the third Engineering Conference of the Institution of Civil Engineers an excellent amount of good work was done, and the benefit which such gatherings have upon the development of the profession is becoming distinctly apparent. We are reviewing elsewhere some of the special papers and discussions, but the opening address of Mr. J. C. Hawkshaw, the President of the Institution, itself furnishes an excellent statement of the nature and objects of the conference.

After referring briefly to the work of the two preceding conferences, Mr. Hawkshaw proceeded to touch upon the important engineering works which have been accomplished since the conference at the Glasgow Exhibition, two years ago.

"Some great works have been completed in the last two years; to name two only, both connected with the distribution of water: the Nile dams for irrigation purposes, and the Coolgardie water-supply; for the latter water is pumped up 1,200 feet and conveyed 300 miles inland in steel pipes.

"The last 2 years have been marked by the work done by the Engineering Standards Committee, work of which it is impossible to overrate the importance to the trade of this country.

"This Committee, which began its work in April, 1901, is the outcome of a Committee appointed by the Institution of Civil Engineers at the suggestion of Sir J. Wolfe Barry. It has been supported actively and financially by the five leading Technical Societies and by the Government, who, on the recommendation of the Board of Trade, have made a grant of £3,000 towards the necessary expenses. Sir F. Hopwood, in conveying to the Standards Committee the decision come to by the Treasury, said that the Board of Trade regarded the work undertaken by the Committee of the highest value to the country at large.

"Some idea of the magnitude of the work undertaken may be gained from the following figures:—there are 23 committees and sub-committees, made up of 296 members, of whom 24 are Government representatives.

"So far only one Committee, that on Building and General Bridge Construction, and one Sub-Committee, that on Tramway rails, have issued the result of their desion, but the conclusions of all are now in an advanced stage."

The subject of engineering education in connection with practical training came in for a due share of attention, and the widening scope of the work of the engineer received emphasis. The demand for specialists, so far from limiting the necessary information required for the practical engineer, has rather extended it.

"What branch is more specialized than that of the electrical engineer, and yet he has to deal with the same problems as the railway engineer in questions of transport and locomotion, as the gas engineer in questions of lighting, with the chemical engineer in questions of the application of electricity to industries, and so on. The engineer who would reach the highest position in his profession should have a knowledge of organization, of administration and of finance, besides the necessary knowledge of the branch to which he specially devotes himself."

That this relation of the engineer to general affairs is being more fully realized is seen in the extent to which members of the engineering profession have entered into public affairs with conspicuous success, and there is every reason to believe that in the future the profession of engineering will prove as direct an entrance into public life as that of the law has been in the past.

Many important problems are now presenting themselves before the engineer and demanding solution. Mr. Hawkshaw refers more specifically to those which appear in London, but these have their counterparts in many other large towns. Thus: "We have dealt with the sewage question, and remove some million of tons of sewage daily by water underground, but we have yet to grapple with the removal of the solid matter, with which we daily pollute, not only the atmosphere of London, but that of the country for many miles round. Many of the fine old trees for which the neighborhood of London was noted, have gone, and moreover, an ever-widening area must follow. The destruction of the fine collection at Kew is only a question of time. Sir W. Thistleton Dyer, after a week's fog, found a deposit of tarry matter on the greenhouses at Kew at the rate of six tons to the square mile. Dr. W. N. Shaw, at the Sanitary Congress at Manchester, estimated, roughly he admits, that it takes seven million tons of air a day to carry away the smoke compared with one million tons of water a day required to carry away the sewage. A bad fog may cost £5,000 a day for light alone, and the estimate made of the cost of smoke pollution to London, which puts it at as much as five millions a year, is probably below the mark.

"Another question which becomes yearly more pressing in London is that of the means of locomotion and transport. Like smoke pollution, our neglect to deal with it is yearly costing the growing population of London a large sum. The King, recognizing the importance of this question, has been pleased to appoint a Royal Commission 'to report as to the measures they deem most effectual for the improvement of the same, by the development and interconnection of railways and tramways, on or below the surface, by increasing facilities for other forms of mechanical locomotion, by better provision for the organization and regulation of vehicular and pedestrian traffit or otherwise; and further to report as to the desirability of establishing some central authority or tribunal to which all schemes of railway or tramway construction of a local character should be referred, and the powers which it would be desirable to confer on such a body.'

"The terms of reference are very wide, and it will tax the powers of even so able a body as the Royal Commission which has been appointed, to find a satisfactory solution. The more facilities you give for traveling and locomotion, the more persons you encourage to travel and take advantage of the better means of transport and locomotion, so that the application of the remedy tends in some measure to spread the disease. Decentralization is what is wanted, and if facilities for transport and locomotion encourage this, it will be a distinct gain to London, especially if it affects factories and workshops, the greatest offenders, with slow and obstructive traffic and smoke pollution."

An important element in connection with the problem of transport is found in the growth of the use of automobile vehicles on highways. At the present time the use of such vehicles is principally governed by considerations of sport and recreation, but with improvements in construction and reductions in cost, the automobile must be reckoned with as an element in the question of the transportation of both persons and merchandise over extended distances.

"We have had experience of how the advent of railways checked the progress of canals and also of motors, which were far advanced nearly a century ago. It is to be hoped that tramways will not again check the progress of motors, and their use, not only for private, but for public service. Tram lines render roads less suitable or serviceable for all other kinds of traffic. It is well worth considering whether it would not be advisable to make roads suitable for motor traffic of all kinds, and let motors serve public as well as private purposes. Railways afford greater facilities than canals, but motors offer greater facilities than either railways or tramways, and though all three are necessary, nothing should be allowed to check the legitimate development of motor traffic."

The questions thus touched upon in the opening address are but a few of those which came up for discussion at the conference, but they serve to show the broadening in the scope of the work of the engineer and the extent to which that work is entering into matters both of daily life and of governmental administration. That this tendency is bound to increase is the firm conviction of all who have had occasion to examine the subject, a conviction which must be strengthened by an examination of the papers and discussions of the conference recently closed.

MODERN VIEWS OF MATTER.

REALIZATIONS OF THE DREAMS OF SCIENTISTS AS FORESHADOWED IN THE LIGHT OF MODERN RESEARCHES.

Sir William Crookes—The Congress of Chemists.

AMONG the important and interesting papers presented at the recent Congress of Chemists, at Berlin, may be mentioned that of Sir William Crookes upon the latest views as to the constitution of matter.

As long as a century ago, the British, generally regarded as a most material and practical people, endeavored to investigate the ultra-mundane particles of matter. In 1809, Sir Humphry Davy, in a lecture at the Royal Institution, maintained that there must be some substance which forms the common basis of all metals. Foreshadowing the modern conception of the electron, he used the expression, "radiant matter," thus showing that he had grasped the ideas which to-day are assumed to express the latest notions of the constitution of matter. Faraday, the illustrious successor of Davy, in various places in his famous "researches," shows that he, too, had grasped the same idea. While the so-called chemical "elements," about seventy in number, are assumed, in accordance with a convenient working hypothesis, to represent the ultimate constituents of all substances, yet it is well understood that these are not the absolute limit of the knowledge of the chemist, the physicist, or the philosopher. There are secrets beyond, and every thoughtful man will do his utmost to penetrate beyond the present temporary barriers.

Sir William Crookes quotes the prophetic words of Sir Humphry Davy:

"If the particles of gases were to move in free space with an almost infinitely great velocity—*i. e.,* to become radiant matter—they might produce the different species of rays, so distinguished by their peculiar effects." At the time these words were uttered, they were passed over almost without notice, but at the present time their profound significance may well be appreciated. In like manner we may recall the experiments of Faraday upon the magnetization of light, and his explanation of magnetic power lines. It is true that in Faraday's day it was sought to explain the phenomena observed by him upon the basis of physical action of the magnetic lines of force, not upon the light itself, but upon the refracting medium through which it passed; but in view of recent researches, it is evident that he saw much further than those who sought to explain the results by more obvious methods.

Thus matters remained until 1879, when Sir William Crookes himself, at the Sheffield meeting of the British Association for the Advancement of Science, brought up again the idea of radiant matter, stating: "Whether the gas originally under experiment be hydrogen, carbon dioxide, or atmospheric air, the phenomena of phosphorescence, shadows, magnetic deflection, etc., are identical."

From that date down to the present the progress has continually been more rapid, and the theoretical work of Faraday, Weber, Lorentz, Gauss, Zöllner, Hertz, Helmholtz, and others has led to the practical work of Becquerel, the Curies, and others, and the marvellous experience with radium, and the phenomena of radiography. The electron theory offers an explanation of the constitution of matter which, in the light of recent experiences, at least, must be considered as acceptable, furnishing, as it does, a clue to the elementary substances of which the coarser chemical elements are composed.

In closing his eloquent address, Sir William Crookes, who, by his own work and researches has contributed as much, if not more, than any other one individual to the development of modern views as to the constitution of matter, said:

"Thus we stand at the frontier where matter and power pass into one another. In this field lie the greatest scientific problems of the future. Here lie the ultimate realities which are as far-reaching as they are wonderful. But it must never be forgotten that theories are only useful as long as they admit of the harmonious correlations of facts into a reasonable system. Directly a fact refuses to be pigeon-holed, and will not be explained on theoretic grounds, the theory must go, or it must be revised to admit the new fact. The nineteenth century saw the birth of new views of atoms, electricity, and ether. Our views to-day of the constitution of matter may appear satisfactory to us, but how will it be at the close of the twentieth century? Are we not incessantly learning the lesson that our researches have only a provisional value? A hundred years hence shall we acquiesce in the resolution of the material universe into a swarm of rushing electrons? This fatal quality of atomic dissociation appears to be universal, and operates whenever we brush a piece of glass with silk; it works in the sunshine and raindrops, and in the lightnings and flame; it prevails in the waterfall and the stormy sea. And, although the whole range of human experience is all too short to afford a parallax whereby the date of the extinction of matter can be calculated, protyle, the 'formless mist,' once again may reign supreme, and the hour hand of eternity will have completed one revolution."

THE MODERN EQUIPMENT OF DOCKS.

ELECTRIC DRIVING OF CRANES, HOISTS, WINCHES, AND OTHER MACHINERY AS COMPARED WITH HYDRAULIC POWER.

Walter Pitt—Institution of Civil Engineers.

ELECTRIC driving of general machinery is now generally regarded as wholly in accordance with the best modern practice, but there are certain special departments of work in which older methods are still regarded with favor. Among these latter may be considered the use of hydraulic power for the operation of dock and harbor machinery, and hence the paper presented by Mr. Walter Pitt at the recent engineering conference of the Institution of Civil Engineers is to be regarded with interest. Mr. Pitt boldly takes the bull by the horns and advocates the substitution of electric for hydraulic power transmission.

The late Lord Armstrong is quoted as saying that he felt satisfied that in point of safety, controllability, and adaptability for various purposes, electricity had little chance of ever rising to the level of hydraulic power. That, however, was more than fifteen years ago, and with all deference to the great authority of any utterance of Lord Armstrong upon an engineering question, there is good reason for believing him at least to be somewhat prejudiced in favor of a system which he himself had done so much to develop.

Mr. Pitt is certainly fully aware of the success which has attended the application of hydraulic power to the equipment of docks.

It was the requirements of docks that first caused attention to be paid to the production of a practicable method of distributing power over a large area, and resulted in the evolution of the hydraulic system of power-distribution, a system which has for many years been worked out with such thoroughness, and which has done such excellent work, that a modern hydraulic dock plant had come to be considered as almost beyond criticism, and yet at the present moment we may say that he would be a more than conservative engineer who would seriously recommend the adoption of a complete hydraulic equipment in a new scheme of any magnitude.

In dockyards we find in every direction, and separated often by considerable distances, appliances that require power to drive them. In the warehouses there are cranes, travelers and lifts; on the quays there are jib-cranes, capstans and coal-tips; and about the entrances and locks there are sluice-lifting gear and gate-winches; in addition, there are generally workshops, sometimes on a very complete scale; and last, but not least, the whole place has to be lighted at night. All these duties have to be performed in the first place effectively, and in the second place economically. The first thing is always to do the work well, rapidly, continuously, with the minimum of stoppages and breakdowns, and also with the minimum of skilled attention; the second consideration is to do all this at the minimum of cost, giving due weight to first cost, upkeep and working expenses.

Viewed from the standpoint of the man who has to use the machinery, and not also to provide it and pay for it, no fault can be found with the operation of the hydraulic appliances to be found in well-equipped docks of the present day. The question is not as to defects in the hydraulic machinery, but rather as to the greater advantages and superior economies of electric driving, for this as for other power applications. The measure of the value of machinery at docks and harbors, in other words, is not greatly different from that obtaining in the machine shop. No establishment can long continue to use advantageously machinery which its competitors have cast aside, scrapped, and replaced with later devices. If the dock and wharf machinery of the leading Continental ports is examined, it will be found almost entirely arranged for electric driving. At Hamburg, Bremen, Rotterdam, Naples, Genoa, etc., the change from hydraulic to electrical appliances along the docks is becoming almost universal. The same is true at important river ports, and a general inspection only is needed to show that in England alone has this transformation been lacking.

There are good reasons for these radical changes. At the time when hydraulic machinery was first introduced there was no other method of power transmission so well adapted for the special work in hand. To-day the electric transmission can do everything accomplished by the hydraulic machinery, and very much more besides, and do it at a cheaper rate. The same central power plant can be both for power and for lighting. This gives a combination of day and night load enabling the most efficient power plant to be installed and operated, and both the mechanical and the electrical engineers have promptly grasped this great advantage.

In order to permit a concrete comparison to be made, Mr. Pitt considers the crane as one of the most important of dockyard appliances. Here there is not much difference between the initial costs of electric and hydraulic crane installation, so far as the machines themselves are concerned. The electric crane is slightly more expensive than the hydraulic, and the electric generating plant is probably somewhat cheaper than the hydraulic power-generating machinery. When we come to consider the connecting link between the power-house and the cranes, however, we find an immense advantage on the side of the electric leads as compared with the cost of the hydraulic mains. As to operative efficiency, the electric crane undoubtedly far exceeds the hydraulic, the quantity of cargo loaded or unloaded per horse power being much greater for the electric than for the hydraulic machine. These facts are fully verified by comparative tests which have been made both at various Continental ports, and also at Glasgow, the working conditions being as nearly similar as actual practice would permit. From data of these tests, given somewhat in detail in Mr. Pitt's paper, it appears that the hydraulic-crane power-consumption varied approximately between one and three times that of the electric crane per cycle of operations. The actual money cost naturally varies in different localities, but it may fairly be considered as mainly proportional to the power consumption.

At the same time, there are other very important considerations to be taken into account. The extreme flexibility of the electric system, the ease with which modifications and extensions may be carried out, and the general convenience may often be of greater money value than the entire cost of the motive power. Machines may in all cases be placed exactly where they are most needed and where they can be operated to the best advantage, and the getting of the power to the machine in the electric system is a matter which need scarcely be considered.

In this respect, Mr. Pitt's paper is somewhat deficient, since it treats mainly of the relative power costs of the two modes of power transmission, and mentions only incidentally what in machine-shop practice has been found to be the greatest advantage of electric driving, the superior convenience and economy in the application of the power.

So far as the actual, practical side of the question is concerned, there really seems to be little room for difference of opinion. The size and importance of the vessels sailing from Continental ports leaves no uncertainty as to the severity of the tests necessarily undergone by any appliances there practically installed. It must, therefore, be only a question of time before methods which have been demonstrated to be successful at such ports as Hamburg or Bremen are adopted at other places where the competition with the great express steamships and heavy freighters of the Continental lines is already being felt.

THE ACTION OF STEAM JETS.

THEORETICAL AND PRACTICAL CONSIDERATIONS IN CONNECTION WITH TURBINES AND OTHER STEAM JET APPARATUS.

Institution of Engineers and Shipbuilders in Scotland.

ALTHOUGH steam jets have been used in connection with injectors, blowers, and similar apparatus for many years, and more recently in some forms of steam turbines, the principles upon which they act are not always fully understood. In the paper recently presented before the Institution of Engineers and Shipbuilders in Scotland by Professor W. H. Watkinson certain phenomena relating to the action of steam jets are discussed in a lucid and interesting manner, and in view of the extent to which jets are employed in various machines, some abstract of this paper will be found acceptable.

It is well known that when steam is obliged to pass through a contracted orifice, what is termed "wire drawing" takes place. In the ordinary reciprocating engine wiredrawing is produced when the ports and passages are too small; when the valve opens slowly; or when the piston speed is very high. The result is a drop in pressure in the cylinder, as compared with the pressure in the steam chest, an effect generally assumed to be injurious. More important are the problems in connection with steam turbines, wire-drawing calorimeters, steam-jet blowers, steam-jet pumps, and also those arising in connection with the possibility of superheating steam by wiredrawing.

The definition of wiredrawing, as given by Professor Watkinson, is that when steam flows from a vessel through an orifice or nozzle into a space where the pressure is lower, without doing work on anything but itself, the steam is said to be wiredrawn. Under these conditions it is sometimes said that the steam has expanded without doing work, but this is a loose form of statement, leading to incorrect conclusions. As a matter of fact, steam never expands without doing work. If it has nothing else to work upon, it will do work on itself, giving itself kinetic energy, and the work which it does on itself is exactly equal to the work which it could have done on a piston under the same difference of pressure and under similar conditions.

The work which is done by expanding steam may be represented graphically in various ways. The most usual form of diagram is the pressure-volume diagram, ordinates representing pressures, and abscissas showing the volumes, the area of the diagram corresponding to the amount of work done. If it is desired to show the work in terms of heat units, the temperature-entropy diagram may be used, in which the ordinates represent temperature and the abscissas entropy, the area being in heat units. In either case the area is a graphical representation of the work done, and in either case the amount of condensation during expansion is shown. Professor Watkinson compares the action of steam upon the piston of a reciprocating engine with that of a jet upon a De Laval turbine, and shows that, all other things being equal, the work absorbed in imparting kinetic energy is the same as the work delivered to the piston.

The form of the nozzle used for a steam jet is an important element in its performance. Experiments with straight or contracting nozzles have demonstrated that the pressure is considerably above atmospheric, and hence the jets increase in diameter on leaving the nozzle. This action shows that some portion of the pressure energy is, in such cases, expended in giving other than axial motion to the steam. The natural result of this diversion of energy is that the axial velocity of the steam is less than it would have been if the whole of the pressure energy had been expended in giving axial motion to the steam. A knowledge of these facts has led to attempts to improve the efficiency of the jet by a modification in the form of the nozzle. As long ago as 1869 Schau discovered that a diverging nozzle was of marked advantage in connection with injectors, and the adoption of this type of nozzle in connection with steam turbines by De Laval enabled him greatly to increase the efficiency of his turbines.

The experiments of Mr. R. D. Napier fully demonstrate that the pressure in an orifice through which steam is flowing is never less than the pressure which, with given initial and final pressures, will give the maximum mass rate of discharge. For steam the pressure in the orifice for the maximum mass rate of discharge is approximately 0.58 of the initial absolute pressure. This holds good provided the pressure in the space into which the steam is flowing is not greater than 0.58 of the initial absolute pressure.

In examining the action of a steam jet the temperature-entropy diagram possesses certain advantages over the pressure-volume diagram, as Professor Watkinson shows. Thus, the pressure-volume diagram shows only the work performed by the steam, while the temperature-entropy diagram, besides showing the total work, also gives the state of the steam at any point of the expansion, and can be made to show the condition of the steam after the kinetic energy has been converted into heat. The manner of applying the diagrams for the solution of the problems connected with the steam turbine is discussed in Professor Watkinson's paper, and also their use in connection with the superheating of steam by wiredrawing. For these details the reader must be referred to the original paper, in which examples are worked out.

A comparison of the theoretical treatment, with the actual results, shows where the defects exist, and where efforts for improvement should be directed. Thus, in an ideally perfect wheel, the steam leaving the wheel would, relatively to the wheel, be flowing parallel to the initial jet, and the velocity of the wheel buckets would be half the velocity of the steam jet. In actual turbines the velocity of the buckets is much less than this, and the two streams are not parallel. For these reasons the steam has a high residual velocity when leaving the wheel, and the residual kinetic energy is, by friction and eddies, converted into heat.

Some of the later attempts to increase the efficiency of steam turbines of the bucket type involve the multiple-action effect, a number of wheels being fixed on the same shaft, and the steam passing from one to the next, and thus utilizing a greater proportion of the kinetic energy of the steam. Such turbines permit lower rotative speeds than those consisting of but a single wheel, while maintaining a high efficiency, and constructive difficulties are thus minimized.

The possibilities of such steam turbines are well shown by the fact that Professor Rateau has constructed direct-connected turbo-ventilators, giving a pressure of half an atmosphere, and turbo-pumps with lifts of several hundred metres. Such installations include plants of several thousand horse power, compressing air to more than 6 atmospheres, and raising water to more than 600 metres, or over 2,000 feet!

INTERNAL-COMBUSTION ENGINES FOR DRIVING DYNAMOS.

THE DEVELOPMENT OF THE LARGE GAS ENGINE AS AN ECONOMICAL AND RELIABLE MOTOR FOR ELECTRIC GENERATORS.

H. A. Humphrey—Institution of Civil Engineers.

AT the recent conference of the Institution of Civil Engineers, a paper which elicited an effective and interesting discussion was that by Mr. Herbert A. Humphrey upon the availability of the internal-combustion engine, and especially of the gas engine for the purpose of driving electric generators. This question is all the more important in view of the increased attention which is being given to the general electric driving of machinery of all sorts, since many of the objections to the gas engine, considered as a direct source of power, disappear when electricity is used as a means of power transmission and application.

"The central-station engineer is now fully alive to the fact that the gas-producer and gas engine constitute the cheapest means of generating electric power where coal is the basis of the energy. The internal-combustion engine is rapidly attaining to sizes of units which are large enough to suit even the big tramway-stations, and, when suitably designed, has proved quite as reliable for driving alternators in parallel as the best steam-engine.

"Single-cylinder single-acting gas-engines, although made in large powers (600 H. P. to 700 H. P.) by the John Cockerill Co., of Seraing, and by Messrs. Richardsons, Westgarth & Co., in England, would not usually be chosen in large units for dynamo-driving, except where regularity is not important. It is interesting to note, however, that 100-H. P. gas engine sets of the single-cylinder single-acting type are actually in use at the Embrach Works, driving belt-driven three-phase alternators in parallel, a small additional fly-wheel being placed on the armature of each machine."

Concerning the various types of construction adopted by different makers, Mr. Humphrey refers first to the *vis-à-vis* engine, made both in England and in Germany, using either two or four cylinders, for powers from 500 to 1,200 horse power. Although this type has done excellent service, it is now being abandoned in favor of double-acting single and tandem-cylinder engines. Engines of the *vis-à-vis* type have been used for driving alternators in parallel on a large scale, showing the entire practicability of using the gas engines for such service.

After reviewing the extent to which engines of the twin-cylinder and double-tandem types have been made by Körting Bros., by the Premier Gas-Engine Company, by the Nürnberg and the Cockerill Companies, Mr. Humphrey proceeded to discuss the lines of improvement open for the gas engine.

"Many attempts have been made to get over the difficulty of a piston-rod stuffing-box, and Messrs. Dick, Kerr & Company years ago constructed and ran at Belfast engines with double-acting pistons and piston-rod glands. The solution of the problem has, however, come gradually, and the Cockerill Company, followed by numerous other makers, have now examples of efficient stuffing-boxes fitted in the closed ends of gas-engine cylinders and giving no trouble. Once this difficulty is removed, the gas-engine must logically be manufactured as a double-acting machine, for by simply duplicating the valve-gear twice the power and twice the number of impulses are obtained from the same size of cylinder without increasing any of the working-stresses. So completely has this fact been recognized that all the leading makers now construct double-acting engines; and powers of 1,000 H. P. with single-cylinder engines, and of 4,000 H. P. with double-tandem engines, of the double-acting type, are readily obtainable. Nearly all the important orders which are now being placed for large gas engines are for the double-acting type, and all the modifications give thoroughly efficient prime movers for central-station work. In fact, the tandem-cylinder engine and the vertical two-cylinder engine are among the chief favorites on the Continent and in England. The Nürnberg Company and the Deutz Company build double-acting tandem engines which leave very little to be desired in the way of simplicity, smooth running, and good turning-moment qualities.

"The Nürnberg engine has the whole of the weight of the piston and piston-rods carried on slides running on guides, so that the piston and stuffing-box friction is reduced to that due simply to the rubbing contact on the piston-rings and the packing in the glands. The front slide constitutes the ordinary crosshead, and the back slide-block is utilized to introduce and discharge the water required for cooling the pistons and piston-rod. This type of engine has so far reached the lowest consumption of both gas and oil for a given output of power."

The new type Westinghouse gas engine bears a close resemblance to a vertical steam engine, there being two double-acting Otto-cycle cylinders carried on A frames and coupled by connecting rods to overhanging cranks below. Among other large gas engines in use and under construction may be mentioned those of the Oechelhäuser type, built by the Deutsche Kraftgas Gesellschaft for the central power station at Ilsede Hütte. Here there are 6 units of 1,000 horse power each, coupled to alternators supplying three-phase current at 10,000 volts pressure to rolling mills at Peine, 5 miles distant, and replacing an equivalent power of steam engines.

The most extensive installations of large power gas engines for electric driving, however, have been made by Körting Bros., of Hannover, and in the tabulated list given by Mr. Humphrey this firm is credited with 37,000 horse power of engines in units of over 200 horse power driving electric generators, and more than 75,000 horse power in units greater than 200 horse power for all purposes. The list of gas engines of 200 horse power and over compiled by Mr. Humphrey gives some interesting information concerning the development and application of internal-combustion motors for electric driving, since it shows the number of engines delivered or in hand by various builders, both for electric driving and for other purposes. Thus, there appears a grand total of 328,065 horse power divided among 515 engines, or an average of 637 horse power per engine. Of this power 206,805 horse power, or nearly two-thirds, is applied to driving electric generators, so that it is evident that the large gas engine has well entered upon the field of electric power-generation.

Mr. Humphrey gives it as his opinion that sufficient attention has not been given to the construction of gas engines intended to take a supply of both gas and air, separately stored under pressure. For central stations of large size the previous compression of the gas and air, so that they may be drawn as required from reservoirs, has much to recommend it, and involves, with proper precautions, no special danger. The advantage of the two-cycle gas engine would then be attained, without the complication of each engine carrying its compressing-plant, together with all the extra valves and gear required. Also, there is no reason why the heavy and somewhat noisy cam-gear on gas engines should not be replaced, and the valves operated by compressed air, or even high-pressure burnt gases stored from the motor-cylinder itself, controlled by a small rotating valve.

The term "internal-combustion engines" embraces oil-engines, but oil-engines above 200 H. P. are rare, and cannot compete in cost of fuel with gas engines using cheap producer-gas, especially when the system of recovering the ammonia from the coal—as in the Mond producer plant—is available. The Diesel oil-engine has attained a high degree of economy, and has been applied to dynamo-driving up to 200-H. P. units.

In general, a gas engine, giving at least one impulse per revolution, is necessary for all central-station direct-coupled dynamo-sets; and in cases of alternators working in parallel, engines should be chosen which give two impulses per revolution. The exact solution of the alternator-in-parallel problem is too complicated, owing to the interaction of the sets, to be given here, but some idea of the relative value of different types of engines for this class of work can be gathered from the Klönne diagrams, which enable the curves for the turning moment, the angular velocity, and the angular deviation to be plotted and compared. By using these diagrams, Mr. Humphrey makes a comparison between the various types, showing the vast advantage of the 4-cylinder, 4-stroke cycle and the 2-cylinder 2-stroke cycle engines over those having a fewer number of power impulses per revolution.

Mr. Humphrey made but a brief reference to the possibilities of the gas turbine, for the reason that experiments now being made upon motors of this type are as yet incomplete, and definite information is not available for publication. The subject of the gas turbine, however, is being pushed experimentally by several investigators, and there is every probability that operative machines may soon be made public.

In view of the mass of data and information contained in Mr. Humphrey's paper his emphatic conclusion appears to be fully justified, namely, that the large central electric stations of the future will employ producer-gas and gas engines, and that existing stations will have gas engines installed for additional power with the ultimate object of the entire replacement of all steam plant.

THE PRESENT INDUSTRIAL CONDITIONS IN SOUTH AFRICA.

A SUMMARY OF THE SITUATION IN THE ENGINEERING FIELD BY A CORRESPONDENT ON THE GROUND.

Mines and Minerals.

IT is a matter of general comment that the recovery of the mining industry on the Rand has been deplorably slow, and that the boom in South Africa, which was hoped for as an immediate result of the ending of the war, has lingered long on the way. Recent reports have been more cheerful, but not yet do they suggest that rush of activity which should follow the restoration of peace, according to all prediction and general precedent. It is interesting, therefore, to get a definite statement of conditions in a form to make comparison with normal standards, and such a statement is given in brief in a communication to *Mines and Minerals* from their correspondent, Mr. F. J. Frank.

"The best month in the history of the Rand was August, 1899, when 85 companies were operating 6,340 stamps, and produced 408,324 ounces, worth approximately $8,291,467. Since the war, owing to the difficulty of obtaining labor, these figures have not been approached, although rapid gains are being made. The returns for January of this year, show that 3,065 stamps were running and produced 198,163 ounces, which is about half what the output was before the war. . . . The lack of labor is, of course, greatly retarding the development work and in that way affects business in general. The number of 'boys' employed previous to the war was 96,704, and at the end of December last year there were but 45,968."

This situation, however, Mr. Frank expects to see relieved, "even if they are obliged to adopt the extreme measure of importing Chinese coolies," and he is evidently disposed to accept the view of a writer in the *African Review,* who predicts for the future "immense prosperity. No goods will be too luxurious to offer, and nothing too costly." The undertakings actually in sight on which this forecast is in part based are thus summed up:

"The amount of gold still in sight on the Rand is variously estimated at $3,000,000,000 to $15,000,000,000. It is thought that eventually 16,000 stamps will be running, but if this estimate be cut down to the conservative figure of 12,000, or 6,000 additional stamps to the present equipment, it means an outlay of over $30,000,000 on surface machinery alone, as it costs at the rate of $5,000 per stamp for the stamps and auxiliary machinery.

"The deep-level mines will need very large plants, no doubt larger than any existing plants, especially in hoisting machinery. The firm that can successfully design and build a hoist for these great depths can find plenty to do in this field.

"While the Rand is a tremendous field, it is by no means the only one in South Africa, and the other gold fields, diamond mines, and coal mines, which are fast being developed, offer a good opportunity for business.

"The railway field is a large one, for it is estimated that 4,000 or 5,000 miles of new railway lines will be built in the next ten years; some of these lines are in course of construction. They will cost about $120,000,000. The existing railways are adding largely to their equipment to meet the demand of a very much increased business.

"It is planned to spend $30,000,000 on the harbors of South Africa in improvements, and the Government has a $150,000,000 irrigation scheme under consideration. All the agricultural districts are without tools or implements."

In this expansion, American manufacturers, Mr. Frank thinks, are going to play an important part, and he quotes from press reports an impressive list of machinery shipments already received or actually ordered from some of the best known makers of electrical, agricultural, or mining machinery in the States—houses already widely known as world traders. But to the less experienced American exporter, Mr. Frank repeats and urges the admonition, so often heard and apparently so little heeded, to give more attention to the details of his foreign shipping business.

"Notwithstanding the excellence in general of the articles offered there have been many bad blunders made, notably in the construction and in the packing; so that, while there is much reason for congratulation because of the showing made, still there is great room for improvement. Where successs has been obtained to any marked degree these faults in packing and construction have been overcome and a volume of business has resulted that has more than repaid any trouble taken or expense incurred.

"Since the war, competition has been very keen, there being more than twenty bids on a recent engine contract and other lines are almost as bad. . . . In the opinion of many, inferior packing and carelessness in omitting some of the necessary parts have caused more loss of trade than the competition. Whether this be true or not, certain it is that many rank errors occur which are certainly the fault of the manufacturers and cause them loss of trade. If shippers could but realize that goods sometimes lie for months exposed to the weather at the coast before they are forwarded up country, greater care in packing might be taken and many reputations saved.

"I saw a case of files that arrived after being eight months en route, and there was but little left but rust. Most explicit instructions had been given by the buyer and, as is so often the case, no attention was paid to his wishes and they were put up about as they would be for a pleasant summer day's journey from New York to Yonkers. It causes great annoyance to the buyer, who loses not only the goods, but also sees his trade go elsewhere because his stock is exhausted. A dealer at home has a wholesale house almost at his doors, but the dealer in South Africa is obliged to wait for months before he can obtain a new consignment, even though he uses the cable, which is an ideal profit destroyer.

"Another item of packing that is too frequently overlooked is that much larger boxes than necessary are used. Large spaces are filled with straw and the coat of vaseline and wrapping paper necessary to protect metal from rust in salt air is left out. Ocean freights are determined by measurement, and so the big-box habit is costly.

"The complaint is often heard that the Americans, in filling foreign orders, act on the principle that as the goods are going so far away, if they are not up to the standard the firms are never likely to hear of any trouble caused. Neither are they, nor likely either to hear of any more orders coming from that source. So many times machinery of inferior workmanship and design and faulty construction is sent when, needless to say, just the opposite course should be pursued if the manufacturers ever hope to build up a successful foreign business. The policy should be that nothing is too good for the foreigner, as he is so far from a base of supply that the goods should be as near perfection as it is possible to make them.

"Many times large orders of machinery are received, only to find that in packing some very essential small parts have been left out, and a delay of some months is caused and frequently a suspension of important work. Extra expense is incurred by cabling and at the risk of being misunderstood. If it is a dealer who has a contract with a time limit and a forfeit attached, it is not hard to imagine the state of his mind, nor his pocketbook, when he finally gets an acceptance. It would be a small expense to the maker to have a thorough system of inspection of all foreign shipments. A few nuts and bolts of odd sizes that are missing make a great difference at the other end of the line where such things are not obtainable."

The trouble is that the American manufacturer too often resorts to foreign trade only in times of home depression, and neglects it as soon as things pick up again in his local field. As long as he plays fast and loose with the business in that way he must expect to be taken up in the same manner—only as a makeshift, when his foreign competitors with a more stable policy are overloaded with orders.

IRON AND COAL IN AMERICA AND GERMANY.

THE RAW MATERIALS USED IN THE PRODUCTION OF IRON AND THEIR TRANSPORTATION IN THE UNITED STATES AND GERMANY.

Herr Macco—Verein Deutscher Eisenhüttenleute.

THE great growth in the production of iron in the United States has attracted the attention of Europe more and more, and has led the technical men of Great Britain and the Continent to study the American iron industry, with the view of determining whether the American supremacy in this field is due to natural causes beyond human control or simply to improved methods of transportation and manufacture, and whether this supremacy is likely to be permanent or is only temporary.

Great Britain and Germany, America's great rivals in the iron industry, have given particular attention to these questions; they have sent individuals and commissions to the United States to carry on investigations, and have discussed the various aspects of the subject at the meetings of their engineering associations, as well as in the technical and even in the lay journals. While final conclusions have not yet been reached, much light has been thrown on the matter, and among the recent contributions to the discussion, a paper by Herr Macco, read before the latest convention of the Verein Deutscher Eisenhüttenleute and published in *Stahl und Eisen,* is of special interest on account of its comparison of American and German conditions.

Herr Macco takes up the various raw materials which enter into the manufacture of iron, and analyzes the figures for their production and cost of transportation. The greater part of his paper is devoted to the United States, and is based on the reports of the Geological Survey and other Government publications. It contains many tables and a mass of valuable information, only a small part of which can be touched upon here.

Considering coal in the first place, the figures for 1901 show that two-thirds of the bituminous coal mined in the United States comes from the Appalachian fields, and that one-sixth is from the "central" coal fields of Illinois and the neighboring States. Pennsylvania leads all the other States by far in the production of bituminous coal, and also produces practically all the anthracite.

During the last eleven years, the average productive capacity of the miners, per man and per day, has increased more than one-quarter, while in Germany it has, if anything, diminished. This favorable showing for America is ascribed to the largely increased use of machinery for coal cutting, 25.7 per cent. of the bituminous output for 1901 being machine mined. In spite of the higher wages paid in America, the prices for coal are much lower than in Germany, the average American price in some years being less than half the German.

In the production of coke Pennsylvania again leads all the States, her output being about two-thirds of the total, and a comparison of the American and German prices shows that the latter are from one and a half to two times as great.

Of late years, the most remarkable phenomenon in the production of iron ore in the United States has been the enormous development of the Lake Superior region, and, particularly, of the Mesaba range. In 1901, Minnesota, where the latter fields are situated, was the leading State in the production of iron ore, its output being 38.45 per cent. of the total, while Michigan was a good second, with 33.4 per cent. As an indication of the magnitude of some of these Minnesota mines, it may be mentioned that the output of one of them, the Fayal, equals the combined product of all the mines in the Sieg district, in Germany. Comparing American iron ores with German, and taking into account the higher percentage of iron in the former, it is found that their average price is decidedly lower than that of the German ores.

Four States—Pennsylvania, Ohio, Illinois, and Alabama—produced 85 per cent of the pig iron in the United States in 1901, and Pennsylvania alone produced over 46 per cent. On comparing the location of the iron furnaces with that of their raw material, it will be found, that, with the exception of some of the iron works in the Southern States, their geographical situation is not favorable. This is not so striking in the case of fuel, although even that has to be carried a greater distance, on the average, than in Germany. Pittsburg, the headquarters of the iron industry, is comparatively near its coal and coke supplies, which include those of the famous Connellsville coke region, but a large portion of its iron ore has to be brought all the way from the upper end of Lake Superior.

The railway freight rates per ton mile, in Germany, are higher than in America, but, as the average haul in the former country is shorter, there is not so much disparity in the total transportation charges. But the water route through the Great Lakes, with the specially-constructed railroads for conveying the ore from the mines to the upper lake ports and from the lower lake ports to Pittsburg, and with all the labor-saving machinery for handling ore, has a most important influence on the American iron industry, and it is very questionable whether the Minnesota ore could stand all-rail transportation to Pennsylvania.

In general, it may be said that the American pig-iron industry possesses excellent raw materials, which are produced very cheaply. Fuel is delivered to the furnaces at a considerably lower cost than in Germany, and the unfavorable geographical location of the ore mines is compensated for by very cheap transportation. The cost of the ore delivered at the works is, however, not much different from that in Germany. Leaving out of consideration temporary setbacks, due to business depression. about the only thing that could endanger the supremacy of the American iron industry would be the failure of its raw-material supplies, and although estimates have been made that some of the richest fields, such as the Connellsville coke district and the Mesaba ore ranges, will be exhausted in a generation or two, it is but reasonable to suppose that within the vast territory of the United States other fields will be opened, which will continue to supply all the material needed for the production of iron and steel for centuries to come

THE MOUNT VESUVIUS RAILWAY.

A COMBINED ADHESION, RACK AND CABLE RAILWAY, ELECTRICALLY OPERATED. UP THE SLOPES OF MOUNT VESUVIUS.

E. Strub—Schweizerische Bauzeitung.

FOR nearly a quarter of a century there has been a cable railway up the cone of ashes which forms the summit of Mount Vesuvius, but to reach the foot of this railway it has been necessary to take a long and tiresome stage ride from Naples. It is therefore not surprising that Messrs. Th. Cook & Son, the well-known tourist agents, who have owned the cable railway since 1887, have long had in view projects for making the crater of the volcano more accessible.

One of the plans proposed was to build a standard-gauge steam railway from Naples to Resina, at the foot of the mountain, and from there have a rack railway, on the Abt system, up to the foot of the cable road. But this project was not well adapted to either the topographical or the traffic conditions, and, besides, its cost, about 4,000,000 francs, was prohibitive. Time went on, and yet no satisfactory plans were submitted, until just before the expiration of the concession which the Messrs. Cook had acquired, they consulted with Herr E. Strub, of Zürich, and after a brief survey of the situation he offered a solution of the problem, which appeared so promising that he was commissioned to prepare the detailed plans on which the road was afterwards built. This railway has just been placed in operation, and a short account of some of its leading features is taken from a recent article by Herr Strub, in the *Schweizerische Bauzeitung.*

Herr Strub's project called for an electric railway from Resina, which is built on the ruins of Herculaneum, on the Bay of Naples, at the foot of Vesuvius, to the beginning of the cable road. Part of the electric railway was to be a rack road, with a special locomotive, but most of it was to be an ordinary adhesion road, with self-propelling cars. This plan seemed all the more reasonable, as an electric railway was already running from Naples to San Giovanni, only a short distance from Resina, to which it was sure to be extended in the near future. The traffic conditions also pointed to an electric road with single cars. Vesuvius is visited annually by about 12,000 persons, the highest record for one day, since the installation of the old cable railway, being 300, and, although the increased facilities will doubtless augment this number, the traffic would not be heavy enough to warrant a steam road with long trains. Another important consideration is the danger to which any structure on the slopes of a volcano is necessarily exposed, and it would not be justifiable, therefore, to expend large sums on such a permanent way as a steam road requires. The electric railway, however, with its comparatively light roadbed and its easy adaptability to grades and curves, is peculiarly fitted for such mountain work.

The railway starts from Resina and runs 3.150 meters to the power station and car shops, at the foot of the hill on which the observatory stands. The rack railway, 1,650 meters in length, rises 344 meters and carries the line up to the observatory, at an altitude above sea level of 594 meters, and the third section of the road, which, like the first section, is an adhesion railway, runs 2,700 meters from the observatory to the the foot of the cable road. The length of the road is, therefore, 7.5 kilometers (4.7 miles), not including the cable railway. The gauge is 1 meter; on the adhesion portions of the line, the minimum radius is 50 meters, and the maximum grade, 8 per cent.; the rack railway has a minimum radius of 80 meters, and a maximum grade of 25 per cent.

The road is so well located that it runs on the natural surface most of the way, the cuts and fills are reduced to a minimum, and there are no bridges. The material for the small amount of masonry construction necessary was right at hand, in the form of lava and puzzolano.

The track consists of steel rails, weighing 40 pounds to the yard (20 kilograms per meter), laid on oak ties, and with angle-iron joints. As the rails are used for the return circuit, the joints are "bonded" by the Brown-Boveri system, in which a conducting and rust-preventing metallic paste is spread between the polished surfaces of the rails and the fish plates. The rack rail is constructed on the Strub system, and is similar to the one on the Jungfrau road. It is in 3.5-meter (11.5-foot) sections and is abundantly strong to resist any stresses to which it may be subjected.

The cars weigh 8,400 kilograms each, have two fixed axles, and have a seating capacity of 24, with room on the platforms for 6 more persons. On each axle there is an electric motor of the usual tramway type. There are two independent methods of braking: Hand brakes and electromagnetic brakes. The latter consist of eight electromagnets, placed side-by-side right above the rails, between the front and rear wheels on each side of the car. Each electro-magnet has a shoe at its lower end, and adjacent magnets have different polarities, there being thus seven magnetic circuits, closed through the rail, so that a powerful braking action is effected.

The rack-rail locomotive weighs 10,400 kilograms, and is able to haul a load of 11,000 kilograms up the maximum grade of 25 per cent. at a speed of 7 or 8 kilometers an hour. It has two shunt-wound motors, of 80 horse power each, which make 650 to 700 revolutions per minute, and are both geared to the toothed wheels which engage with the rack rail. The locomotive has four wheels, and is provided with an elaborate system of both regular and emergency brakes, some of which are automatic in their action. When the cars reach the rack section, their own trolley pole is pulled down, and they are picked up by the locomotive and hauled to the end of the rack railway, after which they proceed by their own power.

The prime movers at the power station are two 100-horse-power gas engines supplied with Dowson fuel gas, which is made on the premises. The two electric generators are shunt-wound, direct-current machines, which have each a maximum current output of 137 amperes, at 550 volts. A storage battery, with a capacity of 256 ampere hours, takes care of load fluctuations and provides a reserve of power.

On the adhesion sections of the road there is one trolley wire, and on the rack section are two, but the latter are in parallel and are used on account of the greater amount of current needed there. All these wires are of hard-drawn copper, 8 millimeters in diameter.

The total cost of this road, including right of way, power station, rolling stock and everything else, was only 1,154,000 francs ($223,000), or 154,000 francs per kilometer ($48,000 per mile). According to Herr Strub, this is by far the cheapest mountain railway that has as yet been built.

This main part of the road is now in operation to the foot of the old cable railway, and it is proposed to remodel the latter, raise its roadbed so as to avoid interruptions due to volcanic dust clogging the track and the cable pulleys, and equip it electrically. The cable road rises 388 meters in a horizontal distance of 720 meters, and so has an average grade of 54 per cent., with a maximum grade of 63 per cent. It terminates in the vicinity of the old crater, at an altitude of 1,182 meters, and about 100 meters below the present active summit crater. The estimated cost of the renovation of the cable railway is 160,000 francs ($31,000), or about one-third the cost of the old cable road.

When a small stretch of electric railway along the shores of the Bay is completed, it will be possible to ride from the center of Naples to the summit of Vesuvius, in a short time and with the greatest comfort and although this method of reaching the crater may not possess the romantic charm of a climb on foot, there is no doubt that it will be far more appreciated by the mass of tourists.

ELECTRIC HAULAGE ON CANALS.

THE FABRE-GANZ SYSTEM FOR HAULING CANAL BOATS BY MEANS OF AN ELECTRIC LOCOMOTIVE.

Julius Szász—Zeitschrift für Elektrotechnik.

FOR many years, canals in the United States have not received the attention they deserve, but in Europe, in spite of the competition of the railroads, they have continued to do a large business, and while many new waterways have been constructed and are being planned, an effort has also been made to improve the old canals so that they can meet modern requirements.

One of the most pressing improvements needed is in the tractive system. From an economic standpoint, the horse and mule are as much out of place on the towpath as in the city street, and in the former case, as in the latter, electricity appears to offer the best substitute.

A great many electric systems for canal-boat haulage have been experimented with, and there are some in successful operation on European canals, but no one of them seems to be entirely satisfactory. A recognition of this fact led to a prize competition for canal-haulage systems which was instituted by the commission charged with the construction of the Teltow canal, which is to connect the Havel and the Spree rivers, near Berlin.

This canal is 37 kilometers long, and will have a yearly traffic amounting to 4,500,000 tons, so that the conditions to be met are rather exacting. Twenty competitors offered plans to the commission, three of which received prizes, and two others, which possessed specially interesting features, were bought outright. One of the latter was the design submitted by Ganz & Co., of Budapest, which embodies some novel ideas, and which is of interest from both a technical and an economic standpoint. This system is described in a recent article by Herr Julius Szász, in the *Zeitschrift für Elektrotechnik*, from which a brief abstract is made.

Among the systems most in use hitherto are those in which an electric automobile runs on the towpath, without any track, and obtains its current from an overhead wire or from storage batteries. Such an automobile deteriorates rapidly, owing to the wear and tear of running on an uneven path, the tractive effort required is great and the operating and maintenance expenses are high. Moreover, the driver is obliged to devote all his attention to the steering of his machine, and there is a great deal of trouble experienced at bridges. Some of these difficulties are overcome by the use of a track on which the locomotive runs. But an ordinary two-rail track involves a large outlay, and unless the locomotive is made excessively heavy the adhesion is too small to get sufficient traction.

Realizing these many difficulties, the Ganz Company, by working out the ideas of M. Fabre, has developed a system which it is believed will satisfy all technical requirements and is, besides, economical to instal and to operate. A single rail is used, and on it runs a locomotive which, instead of the usual horizontal axles, has two pairs of inclined axles. Each axle carries a wheel, and each pair of wheels embraces the rail head, which has an appropriate section not differing much from that of an ordinary T rail. In order to preserve the equilibrium of the locomotive, it has a broad-tired wheel on the side nearest the canal, which runs on the towpath. By this arrangement of the inclined wheels, the pull of the tow line increases the adhesion, which is also augmented by weight of the locomotive producing a wedgelike action on the inclined axles.

The locomotive can be very light, for an increased load on the tow line increases the adhesion. It is operated by a three-phase motor, and current, at a presssure of 500 volts, is taken from two overhead wires, on which runs a small trolley carriage, by means of flexible cables. The rail serves as the third conductor.

At loading stations the tow line is led from the locomotive to a small car, which runs on strong steel cables stretched above the towpath at a height of 10 or 12 meters, and from this car it is carried almost horizontally to a towing mast on the canal boat, thus clearing obstructions. There are many interesting details in this and other parts of the project, which have been carefully worked out, and for which the original article should be consulted. The estimated costs of the installation and operation are remarkably low, and there seems every reason to believe that this system will go a long way toward solving the problem of economical canal traction.

IRRIGATION AND WATER RIGHTS.

THE RECLAMATION OF THE ARID LANDS OF THE WESTERN UNITED STATES, AND THE LEGAL RIGHTS TO THE USE OF WATER FROM STREAMS.

Iron Age—Trans. Assoc. Civ. Engineers of Cornell University.

WHILE the "Great American Desert" of the early geographers has proved to be largely a myth, and much of the territory formerly believed to lie within its borders is now a thriving agricultural region, there yet remains a great deal of land in the western part of the United States where the soil is excellent, but where the rainfall is so slight and uncertain that no crops can be grown.

As the public lands with an adequate natural supply of water have become occupied, homeseekers have taken up some of the arid lands and have made a fair beginning in cultivating them with the aid of water diverted from the neighboring streams or led down from reservoirs in the hills by means of ditches. Somewhat later, corporations began to build irrigation plants, and a large amount of capital is now invested in such enterprises.

It has been felt, however, for several years, that this work should not be left to either individuals or companies, with all their varied and conflicting interests, but that the question of irrigation was properly one of national concern. After some discussion, this feeling has taken definite form in a law passed by Congress about a year ago, and known as the Newlands Irrigation Act, its author being Representative Newlands, of Nevada.

According to an appreciative editorial in the *Iron Age*, "this act provides that the income from the sale of public lands shall be set apart in the Treasury as a separate account, known as the Arid Land Reclamation Fund. It will be swelled from the proceeds of the sale of mining, timber and stone lands, as well as of the arid lands themselves. Judging from the experience of the past three years it should average about $3,000,000 per annum. From the fund thus accumulated the Secretary of the Interior may draw the cost of constructing the irrigation works agreed upon for the reclamation of arid lands. He is authorized to make contracts for such undertakings up to the amount of the fund in the Treasury and unappropriated. To start the work the proceeds from the sale of public lands for the two years preceding the passage of the Newlands act were made available for this purpose, thus permitting immediate undertakings to the cost of $6,000,000. The most interesting feature of this plan is that no part of the expenditure of the Government for irrigation is a gift to the settler. Each project undertaken is automatically self-sustaining. Under each contract undertaken by the Secretary of the Interior the settlers who avail themselves of the advantages created are obliged to pay into the fund, in ten equal installments, such proportion of the cost of the irrigation plant as may be assessed upon the land they take up.

It is not alone necessary to provide the water, however; it must be equitably distributed, and this is a more difficult task than any of the engineering features of irrigation. In the comparatively small area that has been irrigated by private enterprise, there have already been numberless disputes and a multitude of lawsuits over water rights, and there are so many new and complicated questions involved that it will take the wisest legislation, the most equitable judicial decisions and a strong altruistic feeling in the community to avoid a great deal of trouble.

In a lecture delivered before the College of Civil Engineering of Cornell University, and published in the *Transactions of the Association of Civil Engineers of Cornell University*, Mr. Elwood Mead, the Chief of Irrigation Investigation, United States Department of Agriculture, goes into the subject of water rights and shows its far-reaching importance. He says that in Wyoming, "streams are declared to be the property of the State. Any one wishing to divert them must secure a permit from a State board of control. The record of water filings are as carefully kept as the record of land patents. Of the holders, the first in time has the first right; the second in time, the second right; and so on down the list. A State officer called a water commissioner, regulates the headgates of the ditches to protect these rights. When the supply begins to fail, the last ditch built is the first to be closed, so that rights on the same stream differ greatly in value according as they are of early or later date. The water commissioner is therefore the most important officer with whom the farmer comes in contact. He prevents waste, keeps the ditch owners posted as to the volume in the river above and the volume being taken out, and farmers can go on tilling their fields without having to give half their time and all their thoughts to what is being done under other ditches.

"Only a few of the arid States have, however, gone as far as Wyoming in the establishment and protection of water titles. In many of the States, no sort of supervision is exercised over the location or construction of ditches. Any one can divert water from a stream and when there is a shortage the contest over control is fought out in the fields or in the courts."

One of the water-right problems which still awaits a solution is the adjustment of the needs of irrigation to the common law doctrine of riparian rights; another is the extent to which the use of water in irrigation may be permitted to interfere with navigation rights; there are many more, but enough has been said to show the need for the best thought and effort in the settlement of these questions. It can be confidently predicted, however, that these problems will be solved by the strong common sense and good feeling of the people, who will then enjoy the full benefits of the work of legislators and engineers.

THE MAINTENANCE OF MACHINE-SHOP PERSONNEL.

THE APPRENTICESHIP SYSTEM AS ESTABLISHED IN THE WORKS OF THE BROWN & SHARPE COMPANY.

The Iron Age.

THE modern era of what is sometimes called "American" shop practice—the policy of specialization and intensification of work and of the maximum development of mechanical (as opposed to manual) function—is still so young that it has scarcely yet reached the period of the decline and passing of the first generation of workers. To a large extent the shops even of the United States are manned by employees who were trained under the old "all-round" system—or, at least, the problem of the new supply of workers has not become an insistent and vital one, except to the wider vision of some few thinkers. Amonst these there is wide diversity of view and opinion. Mr. H. F. L. Orcutt, in closing his comparative study of European and American machine-shop practice, which appeared in this Magazine in 1899, and has become one of the leading classics in the new mechanical literature, became frankly pessimistic as to the future under the new order. "How to mitigate the incapacitating effects of routine work," he said, "is one of the coming industrial problems." But Prof. Milton P. Higgins—equally fitted by personal knowledge of the daily life of the shop to estimate the tendencies of the times and the influence upon the workers—sees nothing "incapacitating" in the routine—nothing, indeed, but inspiration and uplift. To quote from his article upon "The Influence of Intensified Production" in our Works Management Number: "Let him (the workman) see that there is infinite beauty in every mechanical movement and wonderful interest in every function, that its conception, comprehension, and perfection is the highest work of man, and that the shaping of a perfect screw-head or the production of a faultless pin point is a thing of beauty and a source of enjoyment. Show him the infinite relation of his personal daily toil and duty to all the other great and beautiful things of the outer life of the universe. This is all possible so far as our industrial system is concerned. The capacity of the workman is our only limitation—and what other system can possibly reach down so low and so kindly? If this be true, how can we say that our system is degrading or oppressive upon the masses of workmen because each one must be a specialist and do his particular work better than any other?"

But there remains the practical question just how the new material—or, rather, personnel—is to be received into the shop, and that it is also a very pressing question is beginning to be recognized by some of the larger works. This is well put in a paper read by Mr. William A. Viall before the convention of the National Machine Tool Builders' Association at Worcester, Mass., and reprinted in the *Iron Age*.

"If our beloved President," says Mr. Viall, "is impressed with the fact that certain classes of our people are guilty of race suicide, what would be his opinion regarding the machine tool builders? It seems as though but little, comparatively speaking, has been done toward preparing and fitting for our shops men to take the place of those who are passing from us. All larger manufacturers are undoubtedly constantly beset with requests to recommend men for some of the smaller shops, and men are wanted for all positions, including managers, foremen, and operators of special machines. While all of us are able to make more or less prompt deliveries on machine tools and to manufacture them without limit, we are not able to supply men.

"I appreciate the fact that the tendency of to-day is very largely to specialize among machinists, as well as among professional men, and there may be a feeling among some that there is not the demand for the all-round man that there has been. But I believe there is to-day a demand and an absolute necessity for a large number of these thoroughly trained men—men from whom we can select our foremen and heads of departments. In our own case [that of the Brown & Sharpe Company], we have consistently followed the system, and the result has been that we have been able to man our shop in its managerial departments very largely—in fact, almost entirely—with men who have been trained with us as apprentices. The technical school is doing a training that will furnish, in many cases, engineers, but it does not pretend to give the technical training that is necessary to give us the workmen that we need, and without workmen we can hardly obtain the results that we are endeavoring to obtain."

Mr. Viall then outlines the old apprenticeship system, which, of course, was largely the establishment of a personal relation impossible under modern conditions. The plan of his company is to have the boys regularly indentured, use being made of a printed form which is signed by the apprentice, his parent or guardian, and the company. Mr. Viall continues:

"As to age, we find the limit 16 to 18 to be a period that admits of their finishing their course before they have become too far advanced in age and consequently less amenable to instruction and discipline. That they must be physically sound goes without saying, for it is purposeless to train up young men who are not going to be able-bodied, as the time given to them is entirely lost. We have been obliged to pay some attention to education. I well know that it is not necessary for a good machinist to be able to know when Washington crossed the Delaware or when the Louisiana Purchase was consummated; but if we are to bring up a class of young men who are to be true representatives and men from whom we can draw our foremen and managers, they must have some idea of learning and a love for study. We have required the equivalent of our grammar school course, which presupposes that they know enough of mathematics to know the rule of three, have some idea of decimals, the metric system, etc. Like any education, it is not so much what the boy knows that we are looking to as it is to what he has been trained to, which makes him a much more apt pupil in the shop.

"Very often we are approached by young men who think they want to learn a trade, and their parents wish to have them, who would be utterly unfit for such a work and really have no idea what it means. To indent such a person would be unjust to all parties, and we therefore have provided a term of trial, consisting of 480 hours. If during this time we consider that we wish the young man and he wishes to stay with us the papers are then signed, and these 480 hours are reckoned in with the first year's time. The apprentice must complete 295 days of actual work in a given year before he can start upon the year following, and his pay is regulated strictly according to this record. The company reserve the right to make such adjustment in the apprentice's time as they may see fit by reason of a difference in running time, as for example, short time or unforeseen breaks.

"As to the prices paid, 6, 8, 10 and 14 cents per hour for the respective years, I would say that in addition to this from time to time the apprentices are allowed to have piece work to help them to make whatever they can over and above their regular pay. The work is divided practically as follows:

		Weeks.
First year.	Lathe work: Tools—	
	Single	40
	Double	10
Second year.	Drilling	6
	Milling	12
	Assembling	26
	Erecting	6
Third year.	Erecting	20
	Screw cutting	10
	General work	20
Fourth year.	General work	35
	Scraping	3
	Planing	12
	Total	200

"It is necessary to consider the work that is done, as in any educational system. It is not possible to turn out men who are finished products in any one line, but it does give the apprentices an idea of the general run of work, so that they are able to take hold and specialize later should conditions require it.

"One element that I believe is quite essential is that some one person should have charge of the apprentices. Under the old system every boy was taught to do a piece of work as the one who had him working for him saw fit to teach him. As to the grinding of tools, the drilling of centers and like work, there would be as many different ways of doing it as there were men who had the apprentices in charge. And apprentices are often neglected because the foreman or some other person is too busy to attend to them. Given an instructor of apprentices, however, it is his duty to see that all are instructed in the same manner to do a given piece of work, that time is taken for it, and that it is done properly. Then the general line of work is carried out under the supervision of the various foremen. The instructor of apprentices is also able to look out for those who are away from home. When they are sick or when they may need attention outside of working hours he is at liberty to follow them up and act for the company on behalf of the parents or guardians of the boys. When the number of apprentices is small it is not feasible to have one man devote his time to this work; but I believe that a man could be selected a part of whose duties would be the care of the apprentices."

Mr. Viall recognizes that the system which is well adapted to his works might not serve equally well elsewhere, but he expresses the reasonable hope that it may contain food for thought for other manufacturers, and that it may not be long before all shops have a regularly constituted form of apprenticeship, helping to the creation of an order of competent and reliable journeymen.

NEW YORK'S TRANSPORTATION PROBLEM.

A DISCUSSION OF PLANS FOR HANDLING THE PASSENGER TRAFFIC IN AND ABOUT GREATER NEW YORK.

W. W. Wheatley—New York Railroad Club.

EVERYBODY who has occasion to go about in New York realizes that the transportation problem there is a pressing one. If this problem has not yet been solved, it is not from lack of consideration, for the subject has been written and talked about without end, numberless solutions have been proposed and the officers of all the transportation lines have been inundated with suggestions.

While the final solution of the problem may never be reached until New York passes the zenith of her career, a discussion of the various elements of the question by experts is of value in, at least, stating the problem clearly, and some exstracts from a paper by Mr. W. W. Wheatly, recently read before the New York Railroad Club, may therefore be of interest.

It is estimated that at the beginning of 1903 the population of the five boroughs of New York was 3,632,000. Across the Hudson River, in New Jersey, there are communities, with an aggregate population of about 900,000, which, in a business and social sense, are practically part of the greater city of New York, and which must be included in any consideration of the transportation problem. There is, therefore, at present, a local population "of over 4,500,000 to be transported within the metropolitan territory. Combining the census figures of New York City and tributary New Jersey for 1890, and deducting the result from the combined figures for 1900 it will be seen that the increase of population in the whole territory within ten years was 1,173,880, or at the average rate of over one hundred thousand per annum. Figured in another way, the increase within 10 years was 38 per cent., or at the average of 3.8 per cent. per annum. Although the present growth seems to be equal to that of the past 10 years, the figures are assuming such large proportions it is not likely that the next decade will show a greater rate of increase than 35 per cent. Estimated upon this basis, it appears that the metropolitan population in 1913 should be a little more than six million people.

"While the growth of population has been remarkable, the growth of passenger traffic on the local transportation lines has been still more remarkable, figures showing that in each decade from 1870 to 1900 the passengers carried increased almost 100 per cent. A singular fact which has been obscerved in the case of many growing cities is that for every one per cent. increase in population there is a relative increase of about three per cent. in the passengers carried. It is facts like these which indicate the tremendous probable increase of passenger traffic which the transportation lines of New York, and especially of Manhattan, will be called upon to handle within the next decade.

"The local transportation lines of this entire territory are now handling daily over 4,000,000 people, of which number about 2,500,000 ride in the Boroughs of Manhattan and Bronx, 1,200,000 in Brooklyn and Queens, and 400,000 on the lines just across the river in New Jersey." The average number of passengers carried each day by the surface and elevated lines of Manhattan is about 2,300,000, of which about 75 per cent. is north and south traffic. During the year 1902, about 302,000,000 passengers were carried by the East River, Staten Island and Hudson River ferries and the Brooklyn Bridge, and the average number of people from Long Island, Staten Island and New Jersey who cross the rivers and bays daily to Manhattan is estimated at 419,000, this latter figure representing one-way traffic only. Many of these passengers also use the north and south lines in Manhattan, and so add to the concentration of traffic there.

"The concrete fact upon which all transportation calculations must depend is not the number of people to be carried in a year or a day, but the number to be carried in one hour *in one direction.* The business and shopping district of Manhattan, roughly speaking, may be described as that part of the city between 23rd Street and the Battery. To this district the heavy stream of traffic flows in the morning and back again at night."

The "rush-hour" travel leaving the business district is estimated as follows: 1. To the northward by all elevated and surface lines, 142,000, or 56.8 per cent. of the total. 2. To Long Island and Staten Island by Brooklyn Bridge and by ferries, 64,000, or 25.6 per cent. 3. To New Jersey by ferries, 32,000, or 12.8 per cent. 4. To local Manhattan east and west points, not included above, 12,000, or 4.8 per cent. This makes an average total in the maximum hour of 250,000.

"With a population ten years hence in the metropolitan territory of 6,000,000, and a possible daily passenger travel of 8,000,000, it is probable that the number of people seeking quick transit from the business district between five and six o'clock each evening will be 500,000, instead of half that number as now. The last five years, since the consolidation of the several boroughs into the greater city, have been noteworthy for what has been planned. The next five years, in which many of the plans will reach completion, must always be memorable in the transit development of the city, not only for what has been accomplished, but for the additional plans that yet remain to be made and started toward execution. The problems presented a few years ago to the very excellent Board of Rapid Transit Commissioners, of which William Barclay Parsons is the distinguished chief engineer, and to the city authorities were:

"First.—To annihilate the river barriers on the east and west and furnish a more ready means of intercourse between all the boroughs of the greater city, as well as with the tributary New Jersey territory and the mainland beyond.

"Second.—To provide a comprehensive system of subways, and add to the facilities of the existing surface and elevated lines, so as to give the greatest possible accommodation to the north and south traffic.

"Third.—To provide suitable terminal arrangements and furnish a means of distributing the passengers brought into Manhattan by the new bridges and tunnels from the east and west, so that the local Manhattan lines, already overcrowded, will not have the burden of distribution.

"Fourth.—So to arrange the additional transit facilities that the local traffic, with many stops, will not retard the long haul traffic with few stops, and that the traffic of one line shall not cross at grade the traffic of another line.

The additional transit facilities now authorized, and their probable hourly traffic capacity in one direction, are as follows:

Manhattan Bridge No. 2, East River, eight tracks	92,600
Williamsburg Bridge No. 3, East River, six tracks	63,800
Blackwell's Island Bridge No. 4, East River, six tracks	63,800
Municipal Rapid Transit Tunnel, East River, two tracks	19,200
Pennsylvania Long Island R. R. Tunnel, East River, four tracks	38,400
East River Total	277,800

Pennsylvania Long Island R. R. Tunnel, Hudson River, two tracks	19,200
New York and New Jersey Tunnel, Hudson River, two tracks	19,200
Hudson River Total	38,400
Municipal Rapid Transit Subway No. 1, four tracks, south of Forty-second Street	43,000

"In addition to the facilities already authorized, there is now before the Rapid Transit Commission from its chief engineer, Mr. Parsons, a proposal to increase the Manhattan elevated railroad facilities by the addition of five new tracks on the several divisions downtown, also a proposal to build Subway No. 2 with two tracks, from a connection with the West Side branch of Subway No. 1 at Forty-second Street, through Broadway, University Place, Wooster and Church Streets, to the Battery; also a proposal that the New York Central remove its present freight tracks from the surface of Tenth and Eleventh Avenues and other streets between Fifty-ninth Street and Houston Street and construct an elevated road along the same route with four tracks, two of which should be for passenger service, and be extended by way of West Street to the Battery. There are also proposals for the construction of an East Side branch of Subway No. 1 running north from Forty-second Street under Lexington Avenue to and beyond the Harlem River, and for other branches connecting the trunk subways at various points.

"But the real problem of transit relief relates primarily to the lower end of Manhattan. With the exception of the few bridges and tunnels which deliver the east-and-west travel direct to the business district, it is certain that the swarms of people from the other bridges and tunnels will be thrown upon the local Manhattan lines.

"If the nine additional north and south tracks proposed by Engineer Parsons were to be completed at the same time as Subway No. 1 in 1904, there would undoubtedly be felt an adequate sense of relief; but they are not yet authorized, and it will require from three to five years for their completion. Within five years it is probable that the present traffic will have increased 50 per cent. By that time the new bridges and tunnels to the east and west will have begun to pour their mighty volume of people upon the north and south lines for distribution, and there will be a continued increase in the demand for north and south transit. For every yearly increase of 100,000 in population, there is a corresponding increase of 300,000 in passengers carried. The new north and south facilities will be insufficient to give adequate accommodations."

The Long Island traffic will be far better provided for. The additional bridges and tunnels across the East River already authorized and under construction will have twenty-six tracks, with a maximum hourly carrying capacity, in one direction, of about 277,800, which, with the four tracks of the present bridge added, will give a "rush-hour" capacity of 317,800. When it is remembered that the average "rush-hour" traffic across the East River is now only 64,000, it will be seen that ample provision has been made for the boroughs on Long Island.

The two tunnels now under construction between Manhattan and New Jersey will have a maximum hourly capacity in one direction of 38,400 passengers, more than enough to take care of the present traffic, which is 32,000, though not nearly as great in proportion as that of the new East River tunnels and bridges.

A consideration of all these plans, both those already under way and those merely proposed, shows that the traffic to the northern part of Manhattan and to the Bronx is not adequately provided for. As the direction of the city's future expansion will depend very largely upon the transit facilities offered, it is conceivable that the growth of the Long Island boroughs, and even of the New Jersey suburbs, will outrun that of the northern part of the city. But no matter how many people go to the outlying territory to live, most of them will still do business in Manhattan. That island will become more and more the commercial center of the metropolis and of the whole country, and the improvement of its transportation facilities, to bear a reasonable ratio to its growth in other respects, will continue to be a problem worthy of the best engineering talent and the highest financial enterprise.

THE ENGINEERING INDEX

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The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

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(3) A descriptive abstract,
(4) Its length in words,
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We supply the articles themselves, if desired.

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The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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BRIDGES.

Aar River.

The New Railway Bridge at Brugg, Switzerland (Die Neue Eisenbahn-Brücke bei Brugg, Aargau). An illustrated description of the present viaduct over the Aar, at Brugg, with lenticular trusses, and of proposed new designs, both in steel and in stone. 1000 w. Schweiz Bauzeitung—April 4, 1903. No. 56039 D.

Arch.

Investigation of a Pointed Arch, Pivoted at the Springings (Untersuchung eines Spitzbogens auf Zwei Festen Kämpfergelenken). Prof. G. Ramisch. A mathematical and graphical discussion of pointed arches. Diagrams. 2000 w. Zeitschr d Oesterr Ing u Arch Vereines—April 17, 1903. No. 56014 B.

Bridge Engineering.

The Field of Bridge Engineering and Essentials Necessary for Successful Practice. J. E. Greiner. An outline of the work required in the design, construction and maintenance of structures which support loads. 13500 w. Trans Assn of Civ Engrs of Cornell Univ—1903. No. 55924 F.

Concrete Arches.

Concrete Arch Bridges over the Schlitza near Tarvis (Beton Bogenbrücken über

We supply copies of these articles. See page 797.

die Schlitza bei Tarvis). Julius Stanek A well illustrated description of two concrete arch highway bridges, of about 100 feet span, in Carinthia, Austria. 4 plates. 4000 w. Oester Wochenschr f d Oeff Baudienst—May 30, 1903. No. 56009 D.

Concrete Arch Bridge Over the San Juan River on the Road from Santiago de Cuba to Caney. Eduardo J. Chibas. An illustrated description of the rebuilding of this bridge. The old brick arch, built 50 years ago, was repaired and left, and a concrete arch added on each side to provide sufficient room for the water to pass in time of floods. 1700 w. Eng News—June 18, 1903. No. 55967.

Erection.

Raising a Steel Railroad Viaduct. Brief description of interesting engineering work on the Pennsylvania Railroad, at Becks Run, near Pittsburg. 700 w. Eng Rec—May 30, 1903. No. 55585.

Gignac.

The Bridge of Gignac on the Hérault River (Le Pont de Gignac sur l'Hérault). F. de Dartein. An illustrated description and history of a stone arch bridge in the south of France, built from 1774 to 1810, and comprising a central span of about 159 feet and two side spans of 85 feet. 5 plates. 16000 w. Ann des Ponts et Chaussées—4 Trimestre, 1902. No. 56-155 E + F.

Highway Bridge.

The Springville Bridge. Illustrates and describes details of a 143-foot steel truss bridge, carrying the highway between the towns of Concord and Ashford, N. Y. 900 w. Eng Rec—June 13, 1903. No. 55849.

Laibach.

The Kaiser Franz Joseph Jubilee Bridge at Laibach (Die Kaiser Franz Josefs-Jubiläums Brücke in Laibach). Prof. J. Melan. A well illustrated description of an ornamental highway bridge, on the Melan reinforced concrete system, in the capital of Carniola, Austria. 2 plates. 3000 w. Zeitschr d Oesterr Ing u Arch Vereines—May 22, 1903. No. 56021 B.

Raritan River.

The Raritan River Stone Arch Bridge of the Pennsylvania R. R., at New Brunswick, N. J. This bridge was planned to replace an iron bridge carrying two tracks. One-half the width of the structure has been built along side the iron bridge. The tracks are to be transferred, then the bridge completed. Illustrated description of methods of construction. 900 w. Eng News—June 18, 1903. No. 55964.

Reinforced Concrete.

Reinforced Concrete Bridge Over River Des Peres, Forest Park, St. Louis, Mo. Illustrates and describes the general details of a concrete arch bridge reinforced by corrugated square bars. 1200 w. Eng News—June 11, 1903. No. 55836.

Skew Arches.

The Stresses on Skew Arches. W. C. Kernot. Read before the Victorian Inst of Engrs. An account of an investigation made of the cause of failure in an arch of this type, at Bendigo. Gives an interesting experiment carried out to determine where the stress became intense. 2000 w. Eng News—June 11, 1903. No. 55835.

Standard Plans.

Standard plans for Bridges on the Atchison, Topeka & Santa Fe Ry. Illustrates and describes these plans and the matters governing the designs. 7800 w. Eng News—May 28, 1903. No. 55591.

Steel Trestle.

Bridges on the Eastern Illinois and St. Louis. General plan and description of the 550-ft. double track steel trestle over the Middle Fork of the Big Vermillion River and Illinois Central R. R. 400 w. R R Gaz—June 12, 1903. No. 55840.

Uganda Viaducts.

Building American Bridges in Mid-Africa. A. B. Lueder. Gives the experience of an engineer in constructing twenty-seven viaducts in the jungles. Ill. 5500 w. World's Work—July, 1903. No. 56-121 C.

Vauxhall.

New Vauxhall Bridge. A description and illustration of the present state of this structure. 1500 w. Engr, Lond—May 29, 1903. Serial. First part. No. 55682 A.

CANALS, RIVERS AND HARBORS.

Bank Protection.

Fascine Mattresses for River Beds (Die Anwendung von Grundschwellen). A. Lernet. An illustrated description of fascine mattresses, held together with cross ties, for the protection of the beds of mountain streams against erosion. 1400 w. Oesterr Wochenschr f d Oeff Baudienst—April 18, 1903. No. 56002 D.

Canal Lift.

International Competition for a Canal Lift (Internationale Wettbewerb-Ausschreibung für ein Kanal-Schiffshebewerk). Specifications for competitive designs for a canal lift to overcome a difference of level of 36 meters on the Danube-Oder canal, Austria. Plans must be submitted to the Minister of Commerce, Vienna, before March 31, 1904. 1 plate. 2000 w. Zeitschr d Oesterr Ing u Arch Vereines—May 1, 1903. No. 56018 B.

International Competition for a Canal Lift (Wettbewerbausschreibung für ein Kanal-Schiffshebewerk). Specifications for competitive designs for a canal lift with a height of 36 meters, on the Danube-Oder canal, Austria. Competition closes March 31, 1904, with Minister of Commerce, Vienna. 1 plate. 1500 w. Oesterr Wochenschr f d Oeff Baudienst—May 9, 1903. No. 55019 D.

Croton Dam.

Progress of the Construction of the New Croton Dam. Describes the work, the changes made, present condition, &c., with portions of the construction work. Ill. 3000 w. Eng Rec—June 20, 1903. No. 55973.

The Conditions at the New Croton Dam. Editorial comment on the conditions existing at the site of this dam. 1200 w. Eng Rec—May 30, 1903. No. 55581.

Work on the Great Croton Dam. Arthur H. Battey. A review of the work, the expense, difficulties, and the plans for further increasing the water supply. Ill. 2500 w. Munic Jour Engr—June, 1903. No. 55634 C.

Dams.

The Construction of a Dam Across the Urft River, near Gemünd, Rhenish-Prussia (Vom Bau der Urft-Thalsperre bei Gemünd in der Eifel). An illustrated description of a great dam, with masonry core, designed by Prof. O. Intze, for the purpose of preventing floods, forming a reserve supply of water for irrigation, and furnishing power to a hydro-electric station. Serial, 2 parts. 1 plate. 2500 w. Deutsche Bauzeitung—March 14 and 21, 1903. No. 56071 each D.

The Spier Falls Dam of the Hudson River Water Power Company. An illustrated description of the construction of this very large dam, now nearly completed. 2 page plate. 3300 w. Eng News—June 18, 1903. No. 55968.

Automatic Drop Shutters for the Betwa Irrigation Dam, India. Herbert M. Wilson. A brief outline of the works with an illustrated description of these shutters and their action. 1000 w. Eng News—June 4, 1903. No. 55627.

See also Civil Engineering, Water Supply.

Danube.

The Lowest Navigable Depths and the Low Water Marks on the Danube between Passau and Theben, Austria (Der Niederste Schiffahrtswasserstand und die Relation der Pegelangaben bei Niedrigwasser in der Oesterreichischen Donaustrecke Passau-Theben). Hr. Lauda. A general discussion of the gauge readings and depth of water in the Upper Danube, with tables and diagrams. 2 plates. Serial, 2 parts. 7000 w. Oesterr Wochenschr f d Oeff Baudienst—May 16 and 23, 1903. No. 56006 each D.

Dortmund-Ems Canal.

The Dortmund-Ems Canal (Der Dortmund-Ems-Kanal). Johann Mrasick. An address giving a general account of this Westphalian canal. 6000 w. Zeitschr d Oesterr Ing u Arch Vereines—May 1, 1903. No. 56016 B.

Dover Harbor.

The Dover Harbor Works. Reviews the history of this project, and gives an illustrated description of the works, and methods used in their construction. 6400 w. Engng—June 12, 1903. No. 55948 A.

Dredge.

A Bucket and Suction Dredge for Monte Video, South America (Drague Marine Porteuse à Godets et à Succion, du Port de Montevideo). Ch. Dantin. An illustrated description of a large marine dredge built by Smulders, of Rotterdam. 1 plate. 1500 w. Génie Civil—May 23, 1903. No. 56151 D.

Canadian-Built Hydraulic Dredge. Illustrated description of the modern steel hydraulic dredge, J. Israel Tarte, built by the Polson Iron Works, Toronto, Ont., for the Dominion government. One of the largest and most powerful dredges ever built. 1400 w. Marine Engng—June, 1903. No. 55610 C.

Egyptian Irrigation.

The Assuan Dam and the Irrigation of Egypt (Das Stauwerk bei Assuan und die Bewässerung Agyptens). Karl Grünhut. An illustrated historical and descriptive review of projects for irrigating Egypt, and particularly of the Assuan dam. Maps. 1 plate. 3500 w. Oesterr Wochenschr f d Oeff Baudienst—April 11, 1903. No. 56000 D.

Electric Haulage.

See Street and Electric Railways.

French Waterways.

The Internal Navigation of France. Pierre Baudin. Gives a general view of the system in France and discusses the Bill introduced in Munich, 1901, to improve canals. Map. 8500 w. Contemporary Rev—June, 1903. No. 55868 D.

The Loire—Rhone Canal (Loire—Rhone Kanal). Hr. Zimmler. A review of a report to the French Chamber of Deputies by M. Andiffred on a canal to connect the Loire and Rhone rivers, and a comparison with the Danube-Moldau canal. 1000 w. Oesterr Wochenschr f d Oeff Baudienst—April 25, 1903. No. 56004 D.

German Waterways.

The Navigable Waterways of Germany (Les Voies Navigables de l'Allemagne). M. Duval. An account of the improvement of the navigable rivers and canals of Germany, and more particularly of Prussia, from 1875 to 1900, and the project for the future. Maps. 2 plates. 12000 w. Ann des Ponts et Chaussées—4 Trimestre, 1902. No. 56156 E + F.

Irrigation.

See also Industrial Economy.

Land Subsidence.

The Subsidence of the Land and of the Harbor Bottom at Boston. From advance pages of a report by John R. Freeman, on the proposed Charles River dam. Statement of conclusions, his proof, and reasons for the investigations are given. 1700 w. Eng News—June 18, 1903. No. 55965.

Lighthouses.

The Lighthouses in the Southern Part of the Red Sea (Les Phares du Sud de la Mer Rouge et Leur Installation). J. Benard. A description of four lighthouses recently built near the southern end of the Red Sea by French engineers for the Turkish government. Maps. 1 plate. 9000 w. Mem Soc Ing Civils de France—April, 1903. No. 56161 G.

See also Gas Works Engineering; Marine and Naval Engineering.

London.

The Port of London and Projects for Its Improvement (Etude de l'Administration Actuelle du Port de Londres et du Projet de Transformation). M. Aron. A review and an analysis of the report of a Royal Commission on the improvement of the Thames and the London docks, from both commercial and engineering standpoints. 13000 w. Ann des Ponts et Chaussées—4 Trimestre, 1902. No. 56158 E + F.

North-East Sea Canal.

The North-East Sea Canal. Describes the canal from Kiel to the Elbe and shows why it has not proved a profitable financial concern. 1500 w. Engng—June 5, 1903. No. 55796 A.

Russian Canals.

The Canals and Waterways of the Russian Lake District (Kanäle und Kanalverbindungen Russlands im Seengebiete). N. Romanow. An account, with map, of the system of waterways connecting the Baltic Sea with the Volga and other waterways in the nothwestern part of Russia. 3500 w. Oesterr Wochenschr f d Oeff Baudienst—May 16, 1903. No. 56007 D.

Sault Ste. Marie.

The "Soo" Ship Canal System—The Fiftieth Anniversary of its Commencement. Day Allen Willey. Remarks on the importance of this canal, comparing it with other waterways, and showing the immense amount of traffic which passes through it. Ill. 1500 w. Sci Am—June 6, 1903. No. 55652.

Weirs.

Notes on Weirs in India. Gives illustrated design of examples of the three types found in Upper India. The Okhla Weir across the Jumna River; the Narora Weir at the head of the Lower Ganges Canal; the Parichha Weir in the United Provinces of Agra and Oudh. 4000 w. Engr, Lond—June 5, 1903. No. 55798 A.

CONSTRUCTION.

Borings.

East River Borings for Brooklyn Extension of the New York Rapid Transit. J. C. Meem. A record of the principal events in connection with the East River borings for the Brooklyn extension of the Rapid Transit system of New York. 5400 w. Harvard Engng Jour—May, 1903. No. 55730 D.

Buildings.

The New Schlesinger and Mayer Building, Chicago. Illustrated description of interesting construction work on a department store building. 2000 w. Br Build—May, 1903. No. 55549 C.

Construction Machinery.

See Mechanical Engineering, Miscellany.

Design.

The Effect of Design on Methods of Construction from a Contractor's Point of View. R. W. Newman. Read before the Jr Inst of Engrs. Shows how various small deficiencies in design cause the cost of construction to vary over a wide range. Ill. 2400 w. Engr, Lond—June 5, 1903. Serial. First part. No. 55803 A.

Embankments.

Embankment Consolidators. Abstracts from descriptions in *Le Genie Civil,* of two steam rollers of special form which have been employed in the construction of the Grosbois and Saint Fargeau embankments respectively. Ill. 1200 w. Engr, Lond—June 5, 1903. No. 55800 A.

Fireproof Construction.

Fireproof Building Construction. Frank W. Skinner. An outline of some types, conditions and results. 7700 w. Trans Assn of Civ Engrs of Cornell Univ—1903. No. 55931 F.

Fortifications.

Earth or Armor Protection for Seacoast Fortifications. W. Stavenhagen. Translated from *Marine Rundschau.* A study of the question whether armor or earth give the best protection. 7000 w. Jour U S Art—May-June, 1903. No. 55760 D.

N. Y. Stock Exchange.

The New York Stock Exchange. An illustrated description of this imposing building, recently erected. 1200 w. Archt's & Buildr's Mag—June, 1903. No. 55688 C.

Pipe.

The Use of Iron Pipe in Structural Work. Egbert P. Watson. An illustrated summary of its advantages and ready adaptability to a variety of ordinary structural uses, with some figures showing its comparative cheapness. 1800 w. The Engineering Magazine—July, 1903. No. 56172 B.

Reinforced Concrete.

Reinforced Concrete Construction (Betoneisenbau). Norbert Korzinek. An illustrated gener l review of reinforced concrete construction. 3500 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 2, 1903. No. 56031 D.

A Re-enforced Concrete Floor Used in the Youngstown Car Barn. G. M. Scofield. Describes the construction. Discussion follows. 2800 w. Pro Engr's Soc of W. Penn—April, 1903. No. 55766 D.

Rivets.

Rivets in Structural Steel Work. C. J. Tilden. Notes differences and suggests means of comparison between theory and practice. 1800 w. Harvard Engng Jour—May, 1903. No. 55731 D.

Slope-Walls.

The Design and Cost of Slope-Walls, Including Cost of Quarrying. Describes slope-wall work, the materials used; cost of laying and of quarrying are also discussed, and data given for calculating cost. Ill. 3400 w. Eng News—June 11, 1903. No. 55833.

Steel Stacks.

Self-Supporting Steel Stacks. R. E. Newton. Gives formulae for rivet spacing and for solving the strains in the anchor rods. 1000 w. Eng Rec—June 6, 1903. No. 55718.

Structural Drawings.

Shop Detailing for Structural Steel. F. A. Mitchell. An outline of the principles to be observed in making shop drawings for structural steel work. 3200 w. Technograph—1902-3. No. 55742 D.

Tunneling.

An Interesting Example of Wide Arch Soft Ground Tunneling. An illustrated account of interesting work in building the Atlantic avenue station of the Boston subway extension to East Boston, Mass. 3500 w. Eng News—June 4, 1903. No. 55630.

MATERIALS.

Cement.

Cement—Its Manufacture, What It Is, and How to Test It. Armin Schotte. A short historical sketch, with a description of the difference between natural and Portland cement, the methods of manufacture, and the materials. 3000 w. Pro Engr's Soc of W Penn—April, 1903. No. 55764 D.

Sand Cement for Concrete Works Remote from Transportation Lines. Edward Duryee. Abstract from a paper of the U. S. Geol. Surv. An account of investigations made and the results, with report of costs. 1700 w. Eng News—May 28, 1903. No. 55592.

Portland Cement and Its Manufacture. Prof. Cambessedès in *The Brickbuilder and Cement Maker,* London. Discusses the choice of materials, methods of manufacture, properties, &c. 3500 w. Stone—May, 1903. No. 55763 C.

The Development of the Portland Cement Industry in the Lehigh Valley. Ira Judson Coe. Historical account of this industry and its growth in the section named. 2000 w. Trans Assn of Civ Engrs of Cornell Univ—1903. No. 55926 F.

Concrete.

Concrete. Acheson Smith. Considers briefly concrete arches, and the quality of concrete. Short discussion. Ill. 2400 w. Pro Engrs' Soc of W Penn—April, 1903. No. 55767 D.

Effect of Clay on the Strength of Concrete. J. J. Richey and B. H. Prater. Experimental investigations with tabulated results and general conclusions. 1200 w. Technograph—1902-3. No. 55740 D.

The Relative Strength of Wet and Dry Concrete. James W. Sussex. An account of experimental investigation. 800 w. Technograph—1902-3. No. 55739 D.

Water Tightness in Concrete. Thomas P. Roberts. A short paper citing an instance where water came through the roof of a concrete magazine, rather than through sandy loam soil descending with considerable slope, and discussing the cause. 1200 w. Pro Engrs' Soc of W Penn—April, 1903. No. 55765 D.

Iron Preservation.

Paint as a Preservative of Iron from Rust. An explanation of why the paints best suitable for preserving iron from rust are those in which the pigmental base is an oxide. 3300 w. Engr, Lond—May 22, 1903. No. 55543 A.

Iron Rusting.

The Rusting of Iron and Its Passive Condition (Ueber das Rosten des Eisens und Seine Passivität). M. Mugdan. A communication from Breslau University, giving a scientific discussion of the rusting of iron and of its passive state (when it does not enter into combinations) and the results of experiments. 7000 w. Zeitschr f Elektrochemie—May 28, 1903. No. 56060 G.

Preservation.

The Preservation of Materials of Construction. Continued informal discussion of this subject. Ill. 2300 w. Pro Am Soc of Civ Engrs—May, 1903. No. 55774 E.

Rock Powders.

The Cause of the Cementing Value of Rock Powders. Abstract of a paper by Allerton S. Cushman in the *Journal of the American Chemical Society*. Gives an outline description of the methods of preparing and testing these materials as introductory to a study of certain significant qualities. 3300 w. Eng Rec—June 13, 1903. No. 55847.

Stone.

The Testing of Building Stone. Edwin C. Eckel. Remarks on the desirability of securing uniformity in the methods of investigation, with discussion of tests by crushing, and suggestions of needed tests. 2400 w. Eng and Min Jour—June 20, 1903. No. 55995.

Structural Steel.

Soft and Hard Steel as Structural Materials (Weiches und Hartes Flusseisen als Konstruktionsmaterial). Hr. Eichhoff. Paper before the Verein Deutscher Eisenhüttenleute on the use of mild steel for shipbuilding and other structural purposes Discussion. Diagram. 4500 w. Stahl u Eisen—May 15, 1903. No. 56175 D.

MEASUREMENT.

Chronograph.

A Chronograph for Sounding (Der Sonden-Chronograph). Rudolf Reich. Paper giving an illustrated description of a chronograph for recording the instant when soundings are taken in hydrographical surveying and an account of methods for hydrographical surveying of rivers. 4000 w. Zeitschr d Oesterr Ing u Arch Vereines, April 24, 1903. No. 56015 B.

Curves.

Compound Curves (Ueber Korbbögen). Leopold Herzka. A mathematical and graphical discussion of compound circular curves. Diagrams. 3000 w. Zeitschr d Oesterr Ing u Arch Vereines—April 3, 1903. No. 56011 B.

Sounding.

A New Method of Automatic Sounding for Measuring Dredging. Brief illustrated description. 700 w. Eng News—June 18, 1903. No. 55966.

MUNICIPAL.

Fire Prevention.

The British Fire Prevention Committee and its Work. An account of the work of this committee, which includes the education of the public, to undertake independent investigations and tests of materials, methods and appliances and selected work. 2200 w. Sci Am Sup—June 20, 1903. No. 56112.

Garbage.

The Garbage Reduction Plant at Baltimore. Brief illustrated description of a plant on the Arnold-Edgerton system. 1000 w. Eng Rec—June 13, 1903. No. 55848.

Pavements.

Brick Paving in Iowa. Abstract of a recent report of the Iowa Engineering Soc giving the importance of brick paving in Iowa, and giving some of the results of investigations. 2500 w. Eng Rec—June 13, 1903. No. 55850.

Sewerage.

The Investigations of the Baltimore Sewerage Commission. Kenneth Allen. A description of projects proposed for constructing the best possible sewerage system. States the conditions to be met. Map. 6500 w. Trans Assn of Civ Engrs of Cornell Univ—1903. No. 55930 F.

A Difficult Sewer Crossing Under an Old Aqueduct in Brooklyn. Brief description of a delicate piece of engineering. A 36-inch pipe sewer was forced by means of hydraulic jacks, under the big Ridgewood aqueduct. Ill. 900 w. Eng Rec—May 30, 1903. No. 55586.

The Chicago Intercepting Sewer System. An illustrated general description of the various sections and the present conditions of the work on the intercepting sewer system. 5000 w. Eng News—May 28, 1903. No. 55587.

Street Improvement.

The Improvement of the Freie Strasse in Basel, Switzerland (Die Umgestaltung der Freien Strasse in Basel). An account of the widening and straightening of an important city street, and the necessary changes in buildings. Serial. Part 1. 2000 w. Schweiz Bauzeitung—May 16, 1903. No. 56044 D.

Waste Pipes.

Standards for Waste Pipes (Normalien für Abflussröhren). Standard sizes, materials, construction, etc., of waste pipes for house drainage, recommended by the Austrian Engineers and Architects' Society. Diagrams and tables. 2 plates. 1500 w. Zeitschr d Oesterr Ing u Arch Vereines (Supplement)—April 10, 1903. No. 56013 B.

WATER SUPPLY.

Bay City, Mich.

Bay City Waterworks. E. L. Dunbar. An illustrated historical sketch. 4400 w. Fire and Water—June 23-26, 1903. No. 56145.

Detroit.

The Detroit Water Works. Clarence W. Hubbell. Historical review, with illustrations. 5500 w. Eng Rec—June 20, 1903. No. 55969.

Filtration.

The Filtration Works of the East Jersey Water Company, at Little Falls, New Jersey. Discussion of paper by George W. Fuller. 6000 w. Pro Am Soc of Civ Engrs—May, 1903. No. 55772 E.

Automatic Modules for Regulating the Speed of Filtration. John H. Gregory's discussion of the paper by Charles Anthony, Jr. 2500 w. Pro Am Soc of Civ Engrs—May, 1903. No. 55773 E.

On the Design and Construction of Slow Sand Filters. John H. Gregory. Discusses certain elements which enter into the design and construction of filters as viewed from the standpoint of American practice. Ill. 4800 w. Eng Rec—June 20, 1903. No. 55974.

Filtration at Philadelphia. An illustrated description of the Torresdale filters, Torresdale conduit, and Lardner's Point pumping station. 1400 w. Fire & Water—June 23-26, 1903. No. 56144.

Havana.

The Water Supply of Havana. Charles D. McDowell. An illustrated article giving an account of conditions under the Spanish rule, improvements under American rule, and needed reforms. 2000 w. Munic Jour & Engr—June, 1903. No. 55631 C.

New Orleans.

The Water Supply of New Orleans and Its Improvement. Robert Spurr Weston. Describes the conditions, showing the necessity of obtaining a more satisfactory water supply, and gives an account of the purification investigation of the water of the Mississippi River, with conclusions Ill. 5000 w. Jour N E Water Wks Assn—June, 1903. No. 55954 F.

Pipes.

Pipes and Pipe Laying for the Metropolitan Water Works. Caleb Mills Saville. Concerning the pipe system and the methods of construction employed in distributing water to Boston and its suburban cities and towns. Ill. 8000 w. Jour N E Water Wks Assn—June, 1903. No. 55957 F.

Raising Two Lines of 36-inch Pipes at the Mystic River, Somerville, Mass. John L. Howard. An illustrated description of the method adopted. 2000 w. Eng Rec—June 20, 1903. No. 55976.

Instructions to Inspectors of Cast-Iron Water Pipe, Special Castings and Stop Valves, Philadelphia. Instructions given on contract No. 28, Lardner's Point distribution system, for the improvement, extension and filtration of the water supply. John W. Hill, chief engineer. 1700 w. Eng News—June 11, 1903. No. 55834.

Pressure.

How I Reduce Pressure on a Gravity System. E. H. Gowing. Describes a scheme used at Phillips, Me., where the source of supply was about 600 feet above the general level of the village. Ill. Discussion. 2000 w. Jour N E Water Wks Assn—June, 1903. No. 55952 F.

Pumping Stations.

Management of Pumping Stations. Kenneth Torrance. Gives the system of watches at the Brooklyn Water Works, and discusses general management. 3300 w. Eng Rec—June 20, 1903. No. 55970.

The Pumping Station of the Waterworks of Olten, Switzerland (Das Pumpwerk für die Wasserversorgung der Stadt Olten). Louis Giroud. An illustrated description of an electric pumping plant for raising water from wells to a reservoir for the water supply of a small town. 4000 w. Schweiz Bauzeitung—April 11, 1903. No. 56040 D.

Past and Present Pumping Methods in the metropolitan district of Massachusetts. A. O. Doane. Showing the marked reduction in pumping expenses made possible by the introduction of the Metropolitan supply. 1500 w. Eng Rec—June 20, 1903. No. 55972.

Purification.

Water Purification Experiments at New Orleans. A report of the systems tested, the experiments made with each, and the one adopted. 2800 w. Eng Rec—June 6, 1903. No. 55719.

Water Purification. William R. Copeland. An illustrated article describing the mechanical, and slow sand filters, their operation and the advantages of each. 4000 w. Harvard Engng Jour—May, 1903. No. 55729 D.

Rates.

A Little Talk About Water Rates. John C. Chase. Considers the municipality should pay for water consumed in public buildings, street sprinkling, sewer flushing, fountains, &c., at the same rate as private consumers. Discusses a fair basis for rates, and the wisdom of conducting the water department as a business enterprise. 2000 w. Jour N E Water Wks Assn—June, 1903. No. 55955 F.

St. Louis.

St. Louis Water Supply. R. E. McMath. States the problem to be considered, discussing methods of water treatment, the probable needs of the city, sources of supply, etc., giving the writer's conclusions. General discussion follows. 28,000 w. Jour Assn of Engng Socs—May, 1903. No. 56126 C.

Staines Reservoirs.

Engineering Conference Visits. Illustrated detailed descriptions of the Staines Reservoirs, near the Thames, and of the Great Eastern Railway Company's works at Stratford. 5800 w. Engr, Lond—June 12, 1903. No. 55945 A.

Storage.

The Echo Lake Dam, at Milford, Mass. Leonard Metcalf. An illustrated account of the construction work in raising this dam to increase the storage capacity. States fully the conditions, and gives related information. 3200 w. Jour N E Water Wks Assn—June, 1903. No. 55953 F.

Testing.

The Examination of Water (Ueber die Begutachtung des Wassers). Dr. Adolf Jolles. An address, giving a review of the various impurities of water, and of chemical analysis, biological examination and other methods of testing water. 6000 w. Zeitschr d Oesterr Ing u Arch Vereines—May 29, 1903. No. 56022 B.

Underground Water.

Underground Water. George Bowers. Suggestions on how to obtain and care for it. Followed by general discussion. 5400 w. Jour N E Water Wks Assn—June, 1903. No. 55951 F.

Water Tower.

A Very Tall Steel Water Tower. Illustrated description of the New York Shipbuilding Co.'s water tower, giving abstract of specifications. 2500 w. Eng Rec—June 20, 1903. No. 55971.

Wells.

Water Supplies from Deep Wells. F. J. Warden-Stevens. Discusses forms of deep well construction, the methods used, the supply, etc. 3300 w. Archt, Lond—June 12, 1903. No. 55867 A.

MISCELLANY.

Training.

The Training of the Civil Engineer. Extracts from an article by George F. Swain in the *N. Y. Tribune*. Considers the qualities that fit a man for success in this field, and the best preparation. 1500 w. R R Gaz—June 12, 1903. No. 55841.

ELECTRICAL ENGINEERING

COMMUNICATION.

Combined Service.

Simultaneous Telegraphy and Telephony. Charles C. Duvall. Describes a method, very simple to install, whereby a toll telephone line may be utilized for telegraphic service without interfering with telephonic communication. 400 w. Elec Wld & Engr—June 20, 1903. No. 55990.

Duplex Telephony.

Combined Telephone Circuits (Les Circuits Téléphoniques Combinés). M. Devaux-Charbonnel. A description, with diagrams, of arrangements of telephone circuits for carrying on two conversations over one circuit at the same time, and particularly, of M. Cailho's arrangement, which has operated successfully between Paris and Rouen, 140 kilometers. 3000 w. Bull Soc Internat des Elect—May, 1903. No. 56162 H.

Exchange.

The Exchange of the Ashtabula Telephone Company. Description and illustrations of the new exchange at Ashtabula, Ohio. 1200 w. Elec Rev, N. Y.—June 6, 1903. No. 55704.

Leakage.

On Electric Conducting Lines of Uniform Conductor and Insulation Resistance, in the Steady State. A. E. Kennelly. A mathematical study of the effects of leakage and resistance on currents in telegraph, telephone and other long uniform conductors. 4500 w. Harvard Engng Jour—May, 1903. No. 55-733 D.

Light Telephony.

Ruhmer's System of Light Telephony An illustrated account of what has been accomplished in this field, by Ernst Ruhmer. 900 w. Sci Am—June 6, 1903. No. 55655.

Magnetic Detector.

A Form of Magnetic Detector for Hertzian Waves, Adapted for Quantitative Work. Prof. J. A. Fleming. Read before the Royal Soc. Describes a form of detector constructed by the writer for the purpose of quantitative experiments in connection with Hertzian waves. 1600 w. Elect'n, Lond—June 5, 1903. No. 55787 A.

Pupin System.

German Tests of the Pupin System of Long Distance Telephony. An illustrated account of the experiments made by Siemens and Halske on the subterranean telephone cable, and on uncovered wires, giving in both cases very satisfactory results. 1300 w. Sci Am—June 27, 1903. No. 56146.

Space Telegraphy.

The Development of Spark Telegraphy (Die Entwicklung der Funkentelegraphie). Lieut. Arthur Lengnick. An illustrated historical and descriptive review of the various systems of wireless telegraphy. 3 Plates. Serial. 3 Parts. 14000 w. Oesterr Wochenschr f d Oeff Baudienst—April 18, 25, and May 2, 1903. No. 56001 each D.

The Progress in Wireless Telegraphy. William Maver, Jr. A brief review of progress made. 2000 w. Cassier's Mag —June, 1903. No. 55921 B.

Recent Progress in Wireless Telegraphy. Briefly describes the patents of Reginald A. Fessenden and of Lee de Forest, granted June 9, 1903. 1700 w. Elec Wld & Engr—June 20, 1903. No. 55991.

On a New Process for Tuning Spark Telegraph Stations. Count Arco. Abstract translation from the *Elektrotechnische Zeitschrift.* Reference is made to high frequency systems only. Descriptive. Ill. 1600 w. Sci Am Sup—June 6, 1903. No. 55656.

Switchboards.

Divided Multiple Switchboards. W. Aitken. Abstract of a paper read before the Inst. of Elec. Engrs., London. Considers briefly the methods already used, and explains the system, suggested by the writer to facilitate telephone service. Ill. 2000 w. Elect'n, Lond—May 22, 1903. Serial. 1st part. No. 55534 A.

Telechirograph.

The Gruhn Telechirograph for Transmission of Handwriting. An illustrated description of the construction and operation of this instrument. 1800 w. Elec Wld & Engr—June 20, 1903. No. 55992.

Telegraphy.

Telegraphy and Telephony (Telegraphie und Telephonie). Barth Edler v. Wehrenalp. An address, giving a general review of different systems of electric communication, with illustrations. The first part deals with telegraphy. Serial. Part 1. 5000 w. Zeitschr d Oesterr Ing u Arch Vereines (Supplement)—June 5, 1903. No. 56024 B.

Telephone Cable.

The Anglo-Belgian Telephone Cable. Some particulars of the laying of this cable, the longest submarine telephone cable yet laid, as given by M. Leduc, in a recent paper. 800 w. Elect'n, Lond—June 12, 1903. No. 55880 A.

Telephone Operators.

The Training of Telephone Operators. An illustrated description of the operator's training school of the New York Telephone Co. 4200 w. Elec Wld & Engr—June 20, 1903. No. 55988.

Telephone Power Plant.

The Evolution of the Telephone Exchange Power Board. P. Kerr Higgins. An illustrated article calling attention to the changes during the last ten years, and giving suggestions for the care of the power plant. 2000 w. Elec, N. Y.—June 24, 1903. No. 56116.

Telephony.

Practical Telephone Engineering. William W. Handy. A general description of problems in the design and construction of modern telephone plants in large cities, discussing the methods that will yield the best results. 2500 w. Elec Rev, N. Y.—June 20, 1903. Serial. 1st part. No. 55-934.

DISTRIBUTION.

Arc Converter.

See Electrical Engineering, Miscellany.

Regulation.

Voltage Regulation in Multiple-Wire Systems (Spannungsregulierung in Mehrleiteranlagen). Dr. Hiecke. An address, giving an illustrated description of the apparatus and methods used for measuring and regulating the voltage in the five-wire distribution system of the Allg. Oest. Elek. Gesellschaft of Vienna. 5000 w. Zeitschr f Elektrotechnik—April 19, 1903. No. 56046 D.

Rotary Converters.

The Rotary Converter. George T. Hanchett. A simple description, with diagrams, of the theory of the rotary converter for changing alternating into direct current. 2000 w. Cent Station—June, 1903. No. 55807.

Stark System.

Light, Power, Phone, and Telegraph on One Circuit. A brief description of the invention of Alexander McMartin Stark of a new system of distribution, claiming the advantages of economy and simplicity of construction and operation. 1200 w. Can Engr—June, 1903. No. 55694.

Transformers.

Standard Transformer Voltages. J. S. Peck. Read before the Nat. Elec. Lgt. Assn. Outlines the standard arrangements and the requirements they are designed to meet. 1800 w. Elec Rev, N. Y. —June 13, 1903. No. 55829.

Wiring.

The Insulation and Mechanical Protection of Electric Wiring. Remarks based on practical experience of various systems, enumerating features which may prove of assistance in determining which is the most suitable arrangement for given requirements. 2000 w. Elec Rev, Lond —June 5, 1903. No. 55784 A.

ELECTRO-CHEMISTRY.

Accumulators.

Storage Battery Principles. Herbert L. Towle. The present article deals with the chemistry of the cell. 2000 w. Automobile—May 30, 1903. Serial. 1st part. No. 55553.

A Home-Made Storage Battery Cell. Walter G. Jones. Illustrates and describes a simple cell having a capacity of about 10 ampere-hours. 1500 w. Sci Am Sup—June 20, 1903. No. 56113.

See Electrical Engineering, Generating Stations.

Anodes.

The Wasting Away of the Anode (Das Zerfallen der Anode). Dr. Emil Wohlwill. A discussion of the phenomena taking place at the anode in electro-chemical and electro-metallurgical processes, and particularly the abnormal wasting away of the anode in the form of small particles or dust. 12000 w. Zeitschr f Elektrochemie—April 23, 1903. No. 56056 G.

Alkali Carbides.

Alkali Carbides (Ueber Alkalicarbide). Prof. Henri Moissan. A brief account of researches in the production of carbides of the alkali elements. 800 w. Elektrochem Zeitschr—June, 1903. No. 56065 G.

Calcium Carbide.

The Combustion of Carbon During the Reduction of Calcium Carbide (Ueber die Verbrennung des Kohlenstoffs bei der Calciumcarbid-Reduktion). Fr. von Kügelgen. An account of experiments on the formation of the reaction gases during the electrolytic production of calcium carbide. 2000 w. Zeitschr f Elektrochemie—May 14, 1903. No. 56057 G.

Caustic Soda.

Electrolytic Manufacture of Caustic Soda and Hypochlorites. Discusses the difficulties, and gives a brief account of a number of processes. 4000 w. Sci Am Sup—June 20, 1903. No. 56114.

Chlorine.

The McDonald Electrolytic Cell as a Chlorine Producer. Titus Ulke. An illustrated description of this cell based upon the plant in operation at the Clarion paper mill, at Johnsonburg, Pa., stating its advantages. 1200 w. Eng & Min Jour—June 6, 1903. No. 55713.

Daniell Cell.

The Electromotive Force of the Daniell Cell (Die Elektromotorische Kraft der Daniellschen Ketten). Ernst Cohen and J. W. Commelin. A communication from the Chemical Institute of Utrecht University, giving theoretical and experimental determinations of the e. m. f. of a Daniell cell under various conditions. 2000 w. Zeitschr f Elektrochemie—May 21, 1903. No. 56058 G.

Edison Battery.

The Jungner-Edison Accumulator (Der Jungner-Edison'sche Akkumulator). An article from *Elektroteknisk Tidsskrift*, discussing the question of priority in the invention of the iron-nickel-graphite-alkali storage battery, and taking the side of the Swede, Dr. W. Jungner. 2200 w. Elektrochem Zeitschr—May, 1903. No. 56-064 G.

Electric Furnace.

The Origin, Development and Applications of the Electric Furnace (Der Elektrische Ofen. Sein Ursprung, Seine Entwickelung und Seine Anwendungsformen). Adolphe Minet. A profusely illustrated, historical and descriptive review. Serial. Part 1. 5000 w. Elektrochem Zeitschr—June, 1903. No. 56067 G.

The Electric Furnace. J. Wright. A review of the development, giving illustrated descriptions of types and showing its importance to the chemist and metallurgist. 6500 w. Cassier's Mag—June, 1903. No. 55916 B.

See also Mining and Metallurgy, Iron and Steel.

Electroplating.

Anodes for Electroplating. Prof. C. F. Burgess and Carl Hambuechen. Considers some of the factors which influence the corrosion at the anode, and gives results of some measurements which have been made upon nickel anodes in a nickel-ammonium sulphate plating solution. Ill. 1600 w. Elec Chem Ind—June, 1903. No. 55618 C.

Nickel Cathodes. David H. Browne. On the phenomenon of curling up of electrolytically-deposited nickel sheets. A study of the problem of nickel-plating, with an account of experiments. Elec-Chem Ind—June, 1903. No. 55619 C.

History.

The Development and the Present State of Electro-Chemistry (Die Entwickelung und der Gegenwärtige Stand der Elektrochemie). Dr. Albert Neuburger. An illustrated historical review. Serial. Part 1. 5500 w. Elektrochem Zeitschr—June, 1903. No. 56066 G.

Iron Rusting.

See Civil Engineering, Materials.

Lead Reduction.

The Electrolytic Treatment of Galena and Reduction of Lead. Alec. A. Beadle. Describes briefly the ways in which attempts have been made to reduce galena. 1200 w. Elec Rev, N. Y.—June 13, 1903. No. 55826.

Metal Diaphragms.

Metal Diaphragms (Ueber Metalldiaphragmen). André Brochet. Communication from the Electro-Chemical Laboratory of the Ecole de Physique et de Chimie Industrielles de Paris, giving an account of experiments with metal partitions in electrolytic cells, and of their practical applications. 2000 w. Zeitschr f Elektrochemie—May 28, 1903. No. 56059 G.

Metal Production.

A Process for the Electrolytic Production of Metals (Elektrolytische Metallgewinnung). Hans Albert Frasch. An illustrated description of a process for the production of metals by converting the ores into chlorides and conveying them through a series of electrolytic baths, in which different metals are separated out at different stages. 1200 w. Elektrochem Zeitschr—June, 1903. No. 56068 G.

Ozone.

The Production of Ozone Electrically (Die Darstellung des Ozons auf Elektrischem Wege). Dr. O. Kausch. An illustrated historical and descriptive review of electric methods of producing ozone. Serial. Part 1. 1500 w. Elektrochem Zeitschr—April, 1903. No. 56062 G.

Rectifier.

A New Electrolytic Rectifier (Ein Neuer Gleichrichter). Robert Grisson. An illustrated description of an electrolytic cell, for converting alternating into direct currents, with an electrode of aluminum above a lead electrode, and a cooling coil of lead pipe in upper part of cell. 1600 w. Elektrotech Zeitschr—June 4, 1903. No. 56094 B.

United States.

Technical Instruction and Electro-Chemistry in the United States (Ueber Hochschulunterricht und Elektrochemische Technik in den Vereinigten Staaten). F. Haber. An address before the Bunsen Society, giving the results of the author's observations during his visit to the United States in 1902. The technical instruction in chemistry is discussed, and there is a review of the electrochemical industry. Tables, maps and illustrations. Serial. 3 Parts. 33000 w. Zeitschr f Elektrochemie—April 16, 30, May 7, 1903. No. 56055 each G.

Prof. F. Haber on Electrochemistry in the United States. Abstracts of lectures delivered in Germany, after a visit to America. 2500 w. Elec-Chem Ind—June, 1903. No. 55620 C.

Zinc Process.

An Electrolytic Process for Winning Zinc from Its Ores (Eine Methode zur Elektrolytischen Gewinnung von Zink aus Seinen Erzen). S. S. Sadtler. A description of a process employing an alkaline solution. 1200 w. Elektrochem Zeitschr—April, 1903. No. 56061 G.

ELECTRO-PHYSICS.

Electrons.

The Nature of Electrons (Ueber die Natur der Elektronen). Dr. Gustav Platner. A discussion of the theory of electrons as a means of explaining electric and other phenomena, with particular reference to a book by Joh. Stark on "Electricity in Gases." 3000 w. Elektrochem Zeitschr—May, 1903. No. 56063 G.

Interrupters.

The Development of the Current Interrupter. J. Wright. A review of this important accessory of the induction coil from its commencement to the present. Ill. 1800 w. Elec Rev, Lond—June 12, 1903. Serial. 1st part. No. 55878 A.

Magnetization.

Magnetization by Rapid Oscillations. Ferdinand Braun. A report of experimental investigations. 2000 w. Elect'n, Lond—May 29, 1903. No. 55674 A.

Radiography.

On the Present Status of the X-Rays. M. I. Wilbert. Reviews the history of these rays and the applications made of the discovery, showing how they have added to scientific knowledge. 6000 w. Jour Fr Inst—June, 1903. No. 55734 D.

GENERATING STATIONS.

Accumulators.

The Storage Battery in Lighting and Power Work. J. M. S. Waring. Cites various applications of a battery to lighting and power work. Ill. 1800 w. Cent Station—June, 1903. No. 55808.

Charlottenburg.

The Charlottenburg (Germany) Electric Station (Das Elektricitätswerk Charlottenburg). F. Collischon. A well illustrated description of a handsome central station, which furnishes polyphase current for lighting and power, and direct current for traction, the distributing system and methods of operation. Plans, tables and load diagrams. 3500 w. Serial. 2 Parts. Elektrotech Zeitschr—May 21 and 28, 1903. No. 56088 each B.

Chicago.

New Central Station of the Commonwealth Electric Company of Chicago. Illustrates the Curtis steam turbines to be installed in the new Fisk street station, and gives an outline of the plant. 2500 w. Ir Age—June 18, 1903. No. 55845.

Commutators.

Commutator Losses. W. B. Hird. Read

before the Glasgow Soc. of the Inst. of Elec. Engrs. A discussion of these losses and their causes, showing that some general statements assumed to be correct, are quite incorrect. 2500 w. Mech Engr—June 6, 1903. No. 55727 A.

Development.

The Development of Electric Station Power Plant. Elihu Thomson. Read before the Nat. Elec. Lgt. Assn. Reviews the development of the last twenty-five years, discusses the probable change to turbine driven plants, the possible use of internal combustion engines, etc. 2200 w. Ir Age—June 25, 1903. No. 56137.

Duluth.

Rebuilding the Duluth General Electric Company's Station. Clifford L. Higgins. An illustrated account of the changes made in remodeling. 1200 w. Elec Wld & Engr—June 13, 1903. No. 55830.

Dynamos.

Economy in Continuous-Current Dynamo Design. L. P. Purton. An analytical investigation of the problem of reducing the cost of dynamos without sacrificing efficiency. 1800 w. Elect'n, Lond—June 5, 1903. No. 55785 A.

Friction Losses.

The Determination of the Frictional Losses of Direct Current Machines (Ueber die Bestimmung der Reibungsverluste von Gleichstrommaschinen). C. Kinzbrunner. An illustrated description of a modification of the Dettmar method for determining friction losses in direct-current motors and dynamos by varying the excitation. Diagrams. 1600 w. Elektrotech Zeitschr—June 11, 1903. No. 56096 B.

Future.

The Electric Generating Station of the Future. A. W. Whieldon. Read before the Dublin Soc of the Inst of Elec Engrs. Considers the wastage that is taking place, the latest developments in the use of high-pressure currents, and suggests a studied uniformity in districts with the view to linking together scattered installations. 2800 w. Elec Engr, Lond—May 29, 1903. Serial. 1st part. No. 55678 A.

Hydro-Electric.

Valley Reservoirs as Sources of Power for Electric Plants (Talsperren als Kraftanlagen für Elektricitätswerke). Dr. M. Luxenberg. A discussion of the economy of reservoirs, formed by damming valleys, as sources of power for electric plants, with particular reference to some German examples. Diagram and tables. 3000 w Elektrotech Zeitschr—June 4, 1903. No. 56093 B.

The "Houille Blanche" Congress in France. M. F. Loppé. On the utilization of mountain streams deprived of reservoirs, and illustrated accounts of the water sheds visited by the members of this Congress. 6000 w. Feilden's Mag—June, 1903. Serial. 1st part. No. 55912 B.

Constructive Work for a Water Power Plant near Danville, Va. An illustrated description of an unusually interesting plant, including a structure entirely of concrete extending across the river a distance of about 1,219 ft. 1500 w. Eng Rec—May 30, 1903. No. 55584.

Hydro-Electric Development of the French Broad River, N. C. Charles E. Waddell. An illustrated description of a 2,250-k.w., 6,600-volt plant near Asheville, N. C. 1100 w. Elec Wld & Engr—June 6, 1903. No. 55705.

The Charles A. Chapin Electric Power Plant. An illustrated detailed description of a new hydro-electric generating station on the St. Joseph River, near Buchanan, Mich. 2500 w. Steam Engng—June 10, 1903. No. 55820.

Insulation.

Defective Insulation in Dynamo and Motor Construction. C. E. Farrington. An outline of investigations made to determine the best insulating materials. 4000 w. Cent Station—June, 1903. No. 55809.

London Tramways.

London United Tramways Power Station. An illustrated detailed description of this interesting generating station, with information in regard to the object for which this company was formed, and the area with which it deals. 2400 w. Engr, Lond—June 5, 1903. No. 55799 A.

Marine Standards.

Standards for Electric Installation on Ships (Normalien für die Verwendung von Elektricität auf Schiffen). Standards for electric light and power plants on ships proposed by the Verband Deutscher Elektrotechniker. 500 w. Elektrotech Zeitschr—May 21, 1903. No. 56089 B.

Montreal.

See Street and Electric Railways.

Nashville, Tenn.

Municipal Lighting for Nashville. Illustrates and describes a large electric lighting plant and its successful operation. 2300 w. Munic Jour & Engr—June, 1903. No. 55632 C.

Neversink, N. Y.

The Power Plant of the Neversink Light and Power Company. Illustrated description of a plant to furnish power to the towns of Monticello, Middletown and Port Jervis, N. Y. 1200 w. Eng Rec—June 6, 1903. No. 55717.

Niagara Falls.

A New Power House at Niagara Falls. Orrin E. Dunlap. Description and illustrations of this recently completed plant. 1200 w. Sci Am Sup—June 13, 1903. No. 55855.

Pueblo, Colo.

The Pueblo & Suburban Traction & Lighting Company, Pueblo, Col. An illustrated description of this system. 3500 w. Elec Rev, N. Y.—June 13, 1903. No. 55827.

Sheet Iron.

See Mechanical Engineering, Machine Works and Foundries.

Steam Engines.

See Mechanical Engineering, Steam Engineering.

Telephone Power Plant.

See Electrical Engineering, Communication.

United Kingdom.

"Electrical Review" List of Electricity Supply Works of the United Kingdom. Supplement. Elec Rev, Lond—June 12, 1903. Serial. 2 parts. No. 55877 each A.

Vienna.

The Vienna Municipal Electric Station (Die Städtischen Elektrizitätswerke in Wien). Hugo Fach. A paper, giving an illustrated description of a great generating station, in two parts, one for lighting, the other for traction purposes, in both of which 5,500-volt, three-phase current is generated. Map. 1 Plate. 5500 w. Zeitschr f Elektrotechnik—May 24, 1903. No. 56052 D.

LIGHTING.

Actinic Light.

Some Experiments with Actinic Light. J. W. Kime, M. D. An account of experiments made to determine which bands of the solar spectrum are rich, and which poor in the rays. The object was to gain information bearing on the use of these rays in the treatment of disease. Ill. 2000 w. Sci Am—June 20, 1903. No. 56111.

Camp Lighting.

Electric Lighting of Aldershot Camp. Gives plan, illustrations and description of this undertaking, which includes not only the generating station and distributing network, but also the barrack and building lighting, and some street lighting. 2500 w. Elec Rev, Lond—May 29, 1903. No. 55675 A.

Incandescent Lamps.

Some Points with Regard to Electric Lighting by Incandescent Lamps. Considers briefly some causes of troubles, and means of possibly increasing their efficiency. 1000 w. Elec Engr, Lond—June 12, 1903. No. 55876 A.

Nernst Lamps.

Recent Experiments with Nernst Lamps (Neuere Untersuchungen über die Nernstlampe). Dr. W. Wedding. Paper before the Elektrotechnischer Verein, giving an illustrated account of duration tests of Nernst lamps, the latest model of Nernst lamp, and a comparison between Nernst and arc lamps for small currents. Diagrams and tables. 3000 w. Elektrotech Zeitschr—June 4, 1903. No. 56095 B.

New York Municipal.

Estimates for an Electric Plant for Public Lighting in New York City. Gives the report of Dr. Cary T. Hutchinson on the cost of building and operating a plant to furnish 10,000 arc and 160,000 incandescent electric lamps for lighting the streets, public buildings and places of the boroughs of Manhattan and the Bronx. 2800 w. Eng News—May 28, 1903. No. 55590.

Train Lighting.

The Electric Lighting of a Few Steam Trains of the Prussian Railroads. Abstract of a paper presented at the German Engrs.' convention by Privy Councillor Wichert. Considers individual car lighting, and general train lighting, comparing the two systems, and describes the experimental equipments of the latter system put on two trains in general service. Ill. 7800 w. Ry & Engng Rev—June 13, 1903. No. 55819.

MEASUREMENT.

Aging.

The Aging of German Sheet Iron (Ueber das Altern Deutscher Eisenbleche). Dr. Georg Stern. An account of extensive experiments, made for several years at the works of the Union Electric Co., on the magnetic properties of sheet iron of German manufacture, suitable for transformer cores. Tables and diagrams. 2500 w. Elektrotech Zeitschr—May 28, 1903. No. 56091 B.

A Contribution to the Subject of Aging of Sheet Steel. Thomas S. Allen. An account of tests made to determine whether heating would cause any appreciable increase in the hysteresis loss of commercial sheet steel for armature construction. 1100 w. Elec Wld & Engr—June 20, 1903. No. 55989.

Calibration.

Description of Set for the Calibration of Ammeters and Voltmeters. Fred. Anson Sager. A description of the Crompton potentiometer and its accessories used in the department of Physics at the Univ. of Illinois for the purpose of calibrating direct current ammeters and voltmeters. Ill. 2700 w. Technograph—1902-3. No. 55738 D.

Dynamometer.

An Electric Instrument for Measuring Couples, Power and Work (Mesureur Electrique du Couple, de la Puissance et du Travail Mécanique, de MM. Gaiffe et Gunther). M. Gaiffe. A paper giving a description of an electric apparatus for quickly and conveniently observing the indications of a transmission dynamometer, designed by MM. Gaiffe and Gunther. 1000 w. Bull Soc Internat des Elect—May, 1903. No. 56163 H.

Giorgi System.

The Giorgi System of Units (Das Giorgische Masssystem). Fritz Emde. An explanation and discussion of the system of units proposed by Giovanni Giorgi, and of particular convenience and consistency for electrical measurements. Tables. 3000 w. Zeitschr f Elektrotechnik—June 7, 1903. No. 56054 D.

Magnetic Force.

On the Measurement of Magnetic Force. G. F. C. Searle. A brief account of a method of using a millivoltmeter to indicate directly the magnetic force due to the magnetizing current. 800 w. Elect'n, Lond—June 12, 1903. No. 55879 A.

Ondograph.

Differential Ondograph (Ondographe Différentiel). E. Hospitalier. A description of an improvement in the author's apparatus for recording rapidly varying periodic electric plenomena, particularly alternating current waves. 800 w. Bull Soc Internat des Elect—May, 1903. No. 56164 H.

Oscillograph.

A Portable Oscillograph for Alternating Currents. An illustrated description of the Duddell portable oscillograph, with data relative to its sensibility, and other information of interest. 1500 w. Sci Am—June 20, 1903. No. 56108.

Resistances.

Methods of Combining Resistances. Edwin F. Northrup. A summary of methods which have been used, with descriptions of some new useful ones. 1700 w. Elec Rev, N. Y.—June 20, 1903. No. 55933.

Watt-Hour Meters.

Report of the Reichsanstalt on Schuckert Meters (Mitteilungen der Physikalisch-Technischen Reichsanstalt. Bekanntmachung über Prüfungen und Beglaubigungen durch die Elektrischen Prüfämter). A report and certification from the Reichsanstalt, Charlottenburg, Germany, giving an illustrated description of Schuckert watt-hour meters for direct current. 1600 w. Elektrotech Zeitschr—May 21, 1903. No. 56087 B.

POWER APPLICATIONS.

Coal Mine.

Electric Plant at the Simson Mine of the Rossitz Mining Company, at Zbeschau, near Brünn, Austria (Elektrische Kraftanlage am Simsonschacht der Rossitzer Bergbau-Gesellschaft in Zbeschau bei Brünn). Jaroslav Jicinsky. An illustrated description of a three-phase electric power plant for a coal mine and coal washing and coke oven plant. 1 Plate. 2500 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 25, 1903. No. 56028 D.

Electricity in Mines. Deals with legal questions that arise when the supply of electricity is taken from a supply company. 1800 w. Col Guard—June 5, 1903. No. 55789 A.

Electric Driving.

Electric Driving for Factories (Elektrische Kraftübertragung für Betriebszwecke). Otto Kunze. A discussion of the benefits of electric driving, the different systems, and the increased safety and health of workmen. 2400 w. Oesterr Wochenschr f d Oeff Baudient—May 30, 1903. No. 56010 D.

Applications of Electricity at the Works of Vickers, Sons, & Maxim. A. D. Williamson. Abstract of a paper read before the Inst. of Elec. Engrs. Describes a plant aggregating about 22,500 b. h. p. of generators and motors. 3400 w. Mech Engr—May 30, 1903. Serial. 1st part. No. 55663 A.

Tests of Electric Driving Equipment in the Works of the Morden Frog & Crossing Co. Miles F. Moore. Gives tests made to determine the horse-power required to drive each machine or group of machines, and the alternating-current plant installed. 1200 w. Eng News—May 28, 1903. No. 55588.

The Possible Developments of Electrical Driving in Factories Due to the Supply of Electricity at Cheap Rates by Large Power Companies. J. S. Highfield. A discussion of the important points of this subject. 2000 w. Elect'n, Lond—June 5, 1903. No. 55786 A.

Elevator.

An Automatic Electric Lift. Diagram and description of the "Richmond-Carey" press-button patent electric elevator and its working. 1700 w. Mech Engr—May 23, 1903. No. 55533 A.

Frictional Losses.

See Electrical Engineering, Generating Stations.

Heyland Motor.

An Interesting Phenomenon in Compensated Motors (Ueber eine Interessante Erscheinung an Kompensierten Motoren). Alexander Heyland. A discussion and explanation of the observed phenomenon that the rotor losses are less in "compensated" motors (with commutators on the rotor) than with ordinary induction motors. Diagrams. 1000 w. Elektrotech Zeitschr—May 28, 1903. No. 56092 B.

Polyphase Motors with Commutators (Ueber Drehfeldmotoren mit Kommutatorankern). H. Alexander and Dr. L. Fleischmann. A theoretical discussion of polyphase motors provided with commutators in order to prevent phase shifting, and a consideration of special types of this class. Serial. 2 Parts. 4500 w. Zeitschr f Elektrotechnik—May 10 and 17, 1903. No. 56050 each D.

Iron and Steel.

Electric Power in the Iron and Steel Industries. George E. Walsh. Some notes on the improvements made through the adoption of electricity as a motive power. 1800 w. Elec Rev, N. Y.—May 30, 1903. No. 55594.

Machine Shop.

The Development and Use of the Small Electric Motor. IV. Applications to General Manufacturing Purposes. Fred. M. Kimball. Concluding a comprehensive series by an illustrated review of a variety of industrial, domestic, and commercial uses to which electric driving is especially adapted. Ill. 4500 w. The Engineering Magazine—July, 1903. No. 56168 B.

Group Driving of Machine Tools. J. C. Steen. Gives experience gained in equipping a new shop recently built. 1100 w. Am Engr & R R Jour—June, 1903. No. 55650 C.

Electric Driving in Machine Shops. A. B. Chatwood. Abstract of a paper before the Inst. of Elec. Engrs. On the advantages gained by the use of electricity, with suggestions. 2800 w. Mech Engr—June 6, 1903. No. 55728 A.

Applying a Motor Drive to an Old Lathe. Photograph and diagrams showing the method of adapting an old 60-in. engine lathe to a motor drive, and pointing out the utility of such an equipment and the management required to secure desirable results. 1500 w. R R Gaz—June 19, 1903. No. 55984.

Power Factor.

The Power Factor of Three-Phase Motors with Current Curves of Any Shape (Ueber den Leistungsfaktor von Drehstrommotoren bei Beliebiger Kurvenform). Alberto Dina. A mathematical discussion of the relation of the power factor to the shapes of the potential and current curves. 1200 w. Zeitschr f Elektrotechnik—May 3, 1903. No. 56048 D.

Pumping Plant.

See Civil Engineering, Water Supply.

Repulsion Motor.

A Repulsion Motor (Repulsionsmotor). Marius Latour. An illustrated discussion of an electric motor having an alternating field, wound like an armature and a rotor with commutator. 1200 w. Elektrotech Zeitschr—June 11, 1903. No. 56097 B.

Switches.

Notes on Motor-Starter Switches. A. H. Bate. Read at meeting of Birmingham Sec. of the Inst. of Elec. Engrs. Compares a few of the many forms of starting rheostats, and outlines the principles involved. 3400 w. Mech Engr—May 30, 1903. No. 55664 A.

Test Records.

Power Test of Group Drive Motors. Records of an elaborate series of tests recently made at the Roanoke shops to determine the power required by the various group drive motors for machine driving. 1500 w. Am Engr & R R Jour—June, 1903. No. 55644 C.

Variable Speed.

Alternating Current Motors for Variable Speed. W. I. Slichter. Shows that where an alternating current system is desirable variable speed can be obtained with good results. 2000 w. Trans Am Soc of Mech Engrs—June, 1903. No. 55898.

TRANSMISSION.

Cables.

Electrical Transmission Under Land and Water. Alton D. Adams. On the use of cables in electrical transmission, discussing instances where high-voltage cables are desirable, and present practice. 2500 w. Elec Rev, N Y—June 20, 1903. Serial. 1st part. No. 55935.

California.

A Proposed Transmission for Pumping Purposes. Lewis A. Hicks. A discussion of the project suggested by J. B. Lippincott in a paper on the "Storage of Water on Kings River, California." Ill. 3800 w. Jour of Elec—June, 1903. No. 55932 C.

Montana.

Annual Address to the Montana Socety of Engineers. Joseph H. Harper. Reviews the engineering progress within the state of Montana, and discusses the advances made in power transmission and in wireless work. 8500 w. Jour Assn of Engng Socs—May, 1903. No. 56127 C.

South Bend.

The 25,000-Volt Transmission Plant of the South Bend Electric Company. Illustrated description of a high-tension power-transmission installation situated at Buchanan, Mich. 4200 w. Elec Wld & Engr —May 30, 1903. No. 55599.

MISCELLANY.

Agriculture.

Applications of Electricity to Agriculture. Emile Guarini. A study based on Continental experience, describing various forms of meteorological instruments, but more particularly applications to ploughing, threshing, the felling of timber, haulage, and other heavy work. The examples and cost figures are from actual installations. Illustrated. 4800 w. The Engineering Magazine—June, 1903. No. 56173 B.

Lightning Protection.

The New Earth Connections for Lightning Rods of the Austrian State Telegraph Department (Die Neuen Blitzableiter-Erdleitungen der Staatstelegraphen-Verwaltung). Robert Nowotny. An illustrated description of ground connections which consist of a network of stout wires buried in the earth, with or without coke. 3500 w. Oest Wochenschr f d Oeff Baudienst—May 23, 1903. No. 56008 D.

Speed Measuring.

Technical Notes (Technische Mitteilungen). Dr. G. Benische. An illustrated paper before the Elektrotechnischer Verein, giving descriptions of electric speed measuring apparatus, and of experiments on the division of the alternating current in an electric arc into two direct currents. 1400 w. Elektrotech Zeitschr—May 21, 1903. No. 56090 B.

GAS WORKS ENGINEERING

Acetylene Lighthouse.

The Illumination of the Chassiron Lighthouse with Acetylene Incandescent Lights (Note sur l'Eclairage du Phare de Chassiron à l'Incandescence par l'Acétylène). M. de Joly. An illustrated description of a lighthouse in France, which is lighted with acetylene gas and Welsbach incandescent mantles, and the results of its operation. 3000 w. Ann des Ponts et Chaussées—4 Trimestre, 1902. No. 56157 E + F.

Acetylene Plant.

Acetylene Gas Plant of the Great Northern at St. Paul. Brief illustrated description of a plant for producing and compressing this gas for train lighting. 800 w. R R Gaz—June 12, 1903. No. 55842.

Ammonia.

Sulphate of Ammonia Making by a New Process. J. Ballantyne. Read before the Inst of Gas Engrs. Gives interesting details of a plant at Hamilton, worked by vacuum instead of by pressure. Ill. Discussion. 5200 w. Gas Wld—June 13, 1903. No. 56135 A.

Carbonizing.

The Settle—Padfield Carbonizing Process. Gives a description of this process as explained in the English patent specification. A vertical retort arrangement. Ill. 2000 w. Jour Gas Lgt—June 16, 1903. No. 56136 A.

Carburetting.

The Self-Carburetting of Water Gas in Gas Works. Abstract translation of a communication by H. Dicke, to the *Jour für Gasbeleuchtung*. Information on the working of this process at various places. 4600 w. Jour Gas Lgt—June 9, 1903. No. 55875 A.

Future.

The Future of the Gas Industry. William Upton. Read before the London & Southern Dist. Jr. Gas Assn. Considers important questions involved in the progress of the industry. 3300 w. Gas Wld—June 6, 1903. Serial, First part. No. 55780 A.

Gas-Producer.

The Taylor Gas Producer. Illustrates and describes a producer that can be applied to any existing gas or oil engine. 800 w. Engng—June 5, 1903. No. 55-797 A.

Gas Testing.

Candles and Calories. Prof. Vivian B Lewes. Read before the Inst of Gas Engrs. A discussion of the methods of calculating the illuminating and the calorific values, and of determining their average relations. 7200 w. Gas Wld—June 13, 1903. No. 56130 A.

Intensified Lighting.

High-Pressure Gas Incandescent Lighting. William Sugg. Read before the Inst of Gas Engrs. Describes improvements made in this system of lighting. Ill. Discussion includes also the papers by Mr. Marshall and Mr. Onslow. 9200 w. Gas Wld—June 13, 1903. No. 56133 A.

Later Developments in High Pressure Lighting. A. W. Onslow. Read before the Inst of Gas Engrs. Advocating the use of high-pressure gas, and giving report of success in the lighting of workshops and large spaces. 4000 w. Gas Wld—June 13, 1903. No. 56132 A.

The "Selas" System of Intensified Lighting by Means of an Admixture of Gas and Air. F. D. Marshall. Read before the Inst of Gas Engrs. An illustrated description of this system, stating its advantages, and giving results obtainable. 4000 w. Gas Wld—June 13, 1903. No. 56131 A.

Lewes Process.

The Lewes Process at Tipton. Sidney O. Stephenson. Read before the Inst of Gas Engrs. An account of the Lewes process of the utilization of blue water gas on the full working scale, giving the results. Ill. and discussion. 10400 w. Gas Wld—June 13, 1903. No. 56129 A.

Light Thèory.

Why a Flame Emits Light—The Development of the theory. Prof. Robert Montgomery Bird. Gives a review of ancient ideas in regard to artificial light, and explains the "acetylene theory" advanced by Prof. Vivian B. Lewes. Ill. 4000 w. Pop Sci M—July, 1903. No. 56117 C.

Naphthaline.

Naphthaline. Dr. W. H. Birchmore. Read before the Western Gas Assn. A discussion of results of investigations describing experiments made and giving a full study of the subject. 12000 w. Am Gas Lgt Jour—June 22, 1903. Serial, First part. No. 55998.

New York.

Concentrating Gas Manufacture in New York. Notes on the mammoth works scheme being planned for New York, based on information obtained from W. H. Bradley, while on a European tour to investigate the latest practice in Europe. 2000 w. Jour Gas Lgt—June 9, 1903. No. 55872 A.

Pan-Breeze.

A Machine for Sorting and Washing Pan-Breeze. Illustrates and describes a washing and screening plant by which this work is done automatically and with economy. 1400 w. Gas Wld—June 6, 1903. No. 55781 A.

Photometry.

Photometry and Testing. Walter Grafton. Read before the Inst of Gas Engrs. Discusses the "weak spots" in the present system of testing, showing that some existing beliefs, as regards burners, are wrong. General discussion. 10800 w. Gas Wld—June 13, 1903. No. 56128 A.

The Theory and Practice of "Flicker" or Color Photometry. Jno. F. Simmance. A discussion of this subject with a description of a form of Ritchie photometer—the Simmance-Abady photometer—and an account of its use. 4500 w. Jour Gas Lgt—June 9, 1903. No. 55873 A.

Purification.

Gas Liquor as an Adjunct for the Purification of Water Gas. H. Leicester Greville. Reports results of experiments and discusses the advantages. 1200 w. Jour Gas Lgt—June 9, 1903. No. 55874 A.

Retort-Charging.

Plant for Charging and Discharging Gas Retorts. Summary of a paper prepared for the Societe Technique de l' Industrie du Gas en France, by M. P. Sarrazin, describing the apparatus and its working. Ill. 2800 w. Gas Wld—June 6, 1903. No. 55782 A.

The New Parisian Retort Charging Machine. A correction of a few inaccuracies in a previous article, with supplemental information. Ill. 1200 w. Jour Gas Lgt—May 26, 1903. No. 55621 A.

Self-Lighting Burners.

Canioni's Self-Lighting Burners. M. Auguste Lecomte. Read before the Soc Tech. du Gas en France. Introductory remarks with description of these burners and their action. 1800 w. Jour Gas Lgt—May 26, 1903. No. 55622 A.

Subaqueous Mains.

The High Pressure Gas Main Under the Mississippi River. Thomas D. Miller. Read before the Western Gas Assn. An illustrated account of the laying of a high-pressure main on the bed of the river to supply Algiers with gas. Discussion. 5800 w. Am Gas Lgt Jour—June 8, 1903. No. 55698.

Unproductive Capital.

Unproductive Capital and Its Relation to Renewals. Arthur Valon. Read before the Inst of Gas Engrs. A discussion of the difficulties attendant on over-capitalized works, etc. Discussion. 5500 w. Gas Wld—June 13, 1903. No. 56134 A.

Yield.

Maximum Economical Yield of Gas per Pound of Coal Carbonized. John Somerville. Read before the Western Gas Assn. Introducing a general discussion. Gives results from personal experience. Discussion follows. 5300 w. Am Gas Lgt Jour—June 15, 1903. No. 55817.

INDUSTRIAL ECONOMY

Automobile vs. Locomotive.

See Mechanical Engineering, Automobiles.

Commercial Management.

The Commercial Management of Factories. Ian Andrews. A synopsis of the influence and functions of the office manager in relation to the reduction of the cost of output. 3100 w. The Engineering Magazine—July, 1903. No. 56171 B.

Education.

The Potency of Engineering Schools and Their Imperfections. Dugald C. Jackson. A discussion of methods and their effects on students and on the public. 7000 w. Wisconsin Engr—May, 1903. No. 56124 D.

Education of Engineers and Machinists. Garret Van Arkel. Urging the higher development of the mind and the awakening of an interest in the best littrature and in history, philosophy, economics, the sciences and fine arts. 2000 w. Am Mach—June 18, 1903. No. 55959

Technical Accessories for Academic Lectures on Machine Construction (Technische Mittel für Akademische Vorlesungen über Maschinenbau). Prof. Kammerer. A description of lantern pictures, models and other helps in lectures on technical subjects to large classes. Serial. Part 1. 2500 w. Zeitschr d Ver Deutscher Ing—May 23, 1903. No. 56075 D.

Commercial Education in Europe. Reports of Switzerland, Netherlands, Austria-Hungary, Belgium, Norway and Sweden, and France, with remarks. 2000 w. U. S. Con Repts. No. 1672—June 15, 1903. No. 55757 D.

See also Civil Engineering, Miscellany.

Freedom of Contract.

The Illinois Supreme Court on Freedom of Contract for Labor. George W. Shaw A defense of the right of contract. Discussion in the case of Mathews v. the People. 700 w. Eng & Min Jour—May 30, 1903. No. 55580.

Industrial Efficiency.

The Promotion of Industrial Efficiency and National Prosperity. II. Past Hindrances, and a Suggested Modification of the American Premium system. John B. C. Kershaw. A comparative study of the influence of profit-sharing, premium and bonus system, pointing out the weakness of the first for most situations. 2600 w. The Engineering Magazine—July, 1903 No. 56170 B.

Irrigation.

Water Rights. Elwood Mead. Explains the methods by which running water, which is gathered into streams from the rains and melting snows of the mountains, is divided among the ditches and farms and is bought and sold like any other property. 3600 w. Trans Assn of Civ Engrs of Cornell Univ—1903. No. 55929 F.

Irrigation as a Factor in National Development. Editorial on the great benefit of the Newlands Irrigation Act, which has been in operation in the United States for nearly a year. 1400 w. Ir Age—June 4, 1903. No. 55598.

Kiao-Chau.

The Development of the Kiao-Chau Territory in China, from October, 1901, to October, 1902 (Die Entwickelung des Kiautschou-Gebiets in der Zeit vom Oktober, 1901, bis Oktober, 1902). A general account of railways, harbors, buildings and other development work in the German sphere of influence in China. 2500 w. Glasers Annalen—June 1, 1903. No. 56086 D.

Labor.

What Is for the Best Interests of the Workingman in His Relation to His Employer and to the Labor Union. Thomas Caldwell. A discussion of these two points in the problem of the relation of capital and labor. 4000 w. Ir Age—June 11, 1903. No. 55722.

Employer and Employee. S. H. Stupakoff. Remarks on the conditions and a wise statement of the relations and rights of each. 1200 w. Jour Am Found Assn —June, 1903. No. 55755.

The Labor Capitalist. Frank C. Perkins. Suggests that the laboring classes acquire stock in the industrial enterprises and have a voice in the management of the industries. 3000 w. Cassiers' Mag—June, 1903. No. 55920 B.

The Labor Crisis. Discusses the seeming chaos in organized labor and the disturbance in industry due to these conditions. 1800 w. Gunton's Mag—June, 1903. No. 55743.

Manufacturing Methods.

Modern Manufacturing Methods. Editorial on the methods of management demanded by modern machines if they are to prove a paying investment. 2200 w. Engng—June 5, 1903. No. 55794 A.

Peat.

See Mining and Metallurgy, Miscellany.

Piece Work.

The Piece-Work System from a Piece-Worker's Standpoint. H. B. Kepner. The first of a series of articles discussing the advantages and disadvantages of the system. 1300 w. Am Eng & R R Jour—June, 1903. Serial. First part. No. 55648 C.

Pig Iron Warrants.

Scotch Pig Iron Warrants. Editorial discussing the change which seems to be affecting the pig-iron trade in Scotland. Explains the system of storing iron, how it originated, the manner of conducting business, &c. 2800 w. Engng—June 12, 1903. No. 55949 A.

Raw Materials.

Raw Materials and Transportation Costs in the United States (Rohmaterialien und Frachtenverhältnisse in den Vereinigten Staaten). Hr. Macco. A paper before the Verein Deutscher Eisenhüttenleute, giving extensive statistics of the production and transportation costs of coal, coke, iron ore and pig-iron in the United States, and comparisons with Germany. Maps. 2 plates. 8000 w. Stahl u Eisen—May 15, 1903. No. 56176 D.

Raw Materials and Their Transportation in the United States (Rohmaterialien und Frachtenverhältnisse in den Vereinigten Staaten). Hr. Macco. Paper before the Verein Deutscher Eisenhüttenleute, giving statistics of coal, coke, iron ore and pig iron production, cost, transportation charges, etc., in the United States, and comparisons with German figures. Tables. 7000 w. Serial. 2 Parts. Zeitschr d Ver Deutscher Ing—May 16 and 23, 1903. No. 56076 each D.

Roads.

Pennsylvania's New Good Roads Law. A copy of the Sproul bill, for the purpose of constructing good roads throughout the state, which recently passed the legislature. 5000 w. Munic Jour of Engrs—June, 1903. No. 55633 C.

Safety Devices.

Arrangements for the Protection of Workmen (Einrichtungen für Unfallverhütung und Schutz der Arbeiter). Otto Kunze. An account of safety devices and sanitary arrangements in some modern German shops and factories. 3000 w. Oesterr Wochenschr f d Oeff Baudienst—May 2, 1903. No. 56005 D.

Works Management.

Shop Management. Fred. W. Taylor. An exhaustive treatise on some of the different systems of shop management including methods of timing the rate of work, the amount of the day's work and the methods of rewarding the laborers. 47500 w. Trans Am Soc of Mech Engrs—June, 1903. No. 55893 D.

A Graphical Daily Balance in Manufacture. H. L. Gantt. A continuation of a former paper by the author calling particular attention to the method of setting the task and the method of operating the system by which an exact record is kept. Especially considering the operating. 3800 w. Trans Am Soc of Mech Engrs—June, 1903. No. 55908.

A Machine Shop Problem. Charles Day. A discussion of points in connection with the equipment and management of manufacturing establishments. 5500 w. Trans Am Soc of Mech Engrs—June, 1903. No. 55910 C.

MARINE AND NAVAL ENGINEERING

Air Propeller.

Employment of the Air Propeller for Motor Boat Propulsion. Considers that, under normal conditions, the use of the air propeller could not be justified. 1500 w. Automobile—June 13, 1903. No. 55-811.

Armored Cruiser.

The Spanish Armored Cruiser Cardenal Cisneros. Illustrations and descriptions of a re-designed ship, showing the changes made after the Spanish-American war. 700 w. Engr, Lond—June 5, 1903. No. 55801 A.

Balancing Engines.

The Balancing of Engines (Equilibrage des Machines). H. Brillié. A discussion of the theory and practice of the balancing of various engines. Diagrams and tables. 8000 w. Serial. 3 plates. Génie Civil—May 23, 30 and June 6, 1903. No. 56152 each D.

The Theory of Balancing in Its Application to the Engines of Paddle-Wheel Steamers (Die Theorie des Massenausgleichs in Ihrer Anwendung auf Radschiffsmaschinen). Alb. Achenbach. A discussion of the balancing of paddle-wheel engines, with diagrams and illustrations. 2 plates. 1000 w. Schiffbau—April 8, 1903. No. 56069 D.

Battleships.

A Comparison of the German Battleship "Wettin" with the "Maine." Fred T. Jane. Illustrates the two designs and gives tabulated details with notes. 2000 w. Sci Am—June 13, 1903. No. 55853.

H. M. S. "Commonwealth." Illustration and particulars of this first-class battleship. 1500 w. Engr, Lond—May 22, 1903. No. 55545 A.

Boilers.

See Mechanical Engineering, Steam Engineering.

British Navy.

Great Britain's Naval Supremacy. Sir Charles W. Dilke. An illustrated article giving conclusions from the recent British naval debates. 3000 w. Cassier's Mag—June, 1903. No. 55915 B.

Coal Fleets.

The Coal Fleets of the Great Kanawha River. H. C. Fithian. An illustrated article giving particulars and describing unique features. 2800 w. Marine Engng—June, 1903. No. 55608 C.

Coaling Warships.

Coaling Warships at Sea. Herbert C. Fyfe. Describes the equipment of the U. S. Battleship "Illinois" with the apparatus for coaling at sea, and gives information concerning experiments made by Great Britain and Russia. Ill. 1200 w. Sci Am—June 27, 1903. No. 56149.

Cup Races.

What Cup Races Cost? Editorial on the expense of defending the cup, and the amount of money spent in and around New York on account of these races, and its effect on other Atlantic seaports. 1000 w. Am Shipbuilder—June 18, 1903. No. 55941.

Destroyers.

U. S. Torpedo Boat Destroyers Truxton, Whipple and Worden. H. A. Magoun. A short description of certain features of these vessels which have successfully completed their final acceptance trials, with illustrations and general plans. Plates. 2000 w. Jour Am Soc of Nav Engrs—May, 1903. No. 55859 H.

Exploring Ship.

The Exploring Steamer "Poseidon" (Der Forschungsdampfer "Poseidon"). W. Kaemmerer. An illustrated description of a twin screw steamer built for the German government for the purpose of making scientific investigations at sea, particularly for fishery work. 1200 w. Zeitschr d Ver Deutscher Ing—June 6, 1903. No. 56079 D.

Ferryboat.

The New Ferryboat Newark. An illustrated description of the latest addition to the boats of the Pennsylvania Railroad, operated in New York harbor. 2000 w. Naut. Gaz—June 18, 1903. No. 55881.

Floating Derrick.

The 120-Ton Floating Derrick for the Norfolk Navy Yard. An illustrated description of the construction and operation of one of the largest floating derricks ever built. 1800 w. Eng News—June 25, 1903. No. 56358.

Floating Drydock.

The Cavité Steel Floating Dry-dock. A. C. Cunningham. A description of this dock, giving the specifications and describing details in design and operation showing its value in defending the Philippines. Illustrations, plates, &c. 10000 w. Jour Am Soc of Nav Engrs—May, 1903. No. 55864 H.

"Grangesberg."

S.S. "Grangesberg." An illustrated description of an unusual vessel, designed for carrying ore, and fitted with twenty-four derricks. 330 w. Engrs' Gaz—June, 1903. No. 55776 A.

Ice-Breaker.

Light-Draft River Ice Breaker. Gives an illustrated description of an ice breaker for small river service, built at Danzig, Germany. 1500 w. Marine Engng—June, 1903. No. 55606 C.

"Kaiser Wilhelm II."

New North German Lloyd Express Steamship Kaiser Wilhelm II. An illustrated detailed description of this fine vessel, remarkable for its size and expensive fittings for passenger service. 2800 w. Marine Engng—June, 1903. No. 55605 C.

Lighthouse Service.

How Canadian Waterways are Lighted. Information from the annual report of Lieut. Col. F. Gourdeau, deputy minister of marine and fisheries of the Dominion government. Ill. 1800 w. Marine Rev—May 28, 1903. No. 55555.

Lighthouses.

See Civil Engineering, Canals, Rivers and Harbors, and Gas Works Engineering

Lightships.

Lightships (Les Feux Flottants). M. Ribière. A well illustrated description of several new lightships for the French coast, some with a crew and some without, the system of lighting with compressed oil gas, the sound signal apparatus, and other features. 3 plates. 7000 w. Ann des Ponts et Chaussées—4 Trimestre, 1902. No. 56154 E + F.

Marine Engines.

Marine Engine Designs. Comparative Practice, 1903. John Calder. Considers the ways in which the demand for greater power has been met, and the classes of service for which the designs must be made. Gives tabulated comparative practice. 3000 w. Marine Engng—June, 1903. No. 55611 C.

Monitors.

The Official Trial of the U. S. S. Florida. Lieut. Com. Albert Moritz. An illustrated detailed description of the vessel and its equipment, with report of trial. 7800 w. Jour Am Soc of Nav Engrs—May, 1903. No. 55865 H.

Petrol Launch.

The King's Petrol Motor Launch. Illustrations with brief description. 350 w. Auto Jour—June 13, 1903. No. 55936 A.

The King's New Launch. Illustrated description of a petrol launch built for the King of England. 1000 w. Engng—June 19, 1903. No. 56312 A.

Polar Navigation.

About Some Important Polar Navigations to High Latitudes. Dr. Arnaldo Faustini. An account of journeys to very high latitudes in the 17th and 18th centuries, with comments on their value. 3900 w. Jour Fr Inst—June, 1903. No. 55735 D.

Propeller Shafts.

Improvements in Propeller Shaft Bearings. A Scott Younger. Read before the

British Inst of Nav Archts. A record of some experiments made and the results, with a description of some improvements. Ill. 800 w. Naut Gaz—June 18, 1903 No. 55882.

Schooner.

Six-Masted Schooner, Addie M. Lawrence. Illustrated description of this large wooden sailing vessel, built at Bath, Me. 900 w. Marine Engng—June, 1903. No. 55612 C.

Screw Propellers.

Screw Propellers of U. S. Naval Vessels. Lieut. Charles W. Dyson. Criticisms based on the findings of the efficiencies of performance of the different screws as shown by applying of Froude's formulae, using as data the actual data of the trials of the vessels. 14000 w. Plates and tables. Jour Am Soc of Nav Engrs —May, 1903. No. 55857 H.

Shallow Draft.

Improved Designs of Screw Propulsion for Shallow Draft Boats. Illustrates and describes designs by A. F. Yarrow for propelling boats in shallow water. A device for improving the efficiency of the shallow-draft boat for towing purposes is explained. 1700 w. Sci Am Sup—June 6, 1903. No. 55657.

Ship Machinery.

Engineering Life on an Atlantic Liner. Harry Cornell. A narrative of the routine of the operation and maintenance of the machinery of the steamship "St. Louis." 2000 w. Steam Engng—June 10, 1903. No. 55821.

Ship Resistance.

The Motion of Water During the Passage of Ships and Its Influence on Ship Resistance (Die Wasserbewegung Während der Fahrt von Schiffen und Ihr Einfluss auf den Schiffswiderstand). R. Haack. A paper giving a discussion of experiments on the Dortmund-Ems canal, and of the question of ship resistance particularly in canals and shallow waters. Illustrations and diagrams. Serial. 2 parts. 8000 w. Zeitschr d Ver Deutscher Ing—May 16 and 30, 1903. No. 56072 each D.

Speed and Coal.

Speed and Coal Consumption Curves. Lieut. Daniel S. Mahoney. The importance of securing these representations of the relation existing between coal consumption and speed in warships. How the curves are constructed; what they show, &c., is presented. 2800 w. Jour Am Soc of Nav Engrs—May, 1903. No. 55858 H.

Submarine.

Official Trial of the Submarine Boats "Grampus" and "Pike." Leo Morgan. Brief illustrated description, with report of trials. 4500 w. Jour Am Soc of Nav Engrs—May, 1903. No. 55866 H.

Tonnage Laws.

Tonnage Laws of the United States. Theodore Lucas. Explains how ships are measured for determining the tonnage, and considers how a saving in gross tonnage may be effected. 2200 w. Naut Gaz—June 4, 1903. No. 55697.

Turbine Steamer.

The New Turbine Channel Steamer Queen. Illustration and brief description of a channel steamer for the South-Eastern and Chatham Ry. 1200 w. Engr, Lond—June 19, 1903. No. 56329 A.

The First Cross-Channel Turbine Steamer. H. C. Fyfe. A description of a vessel now building which is expected to create a revolution in cross-channel passenger traffic. 1000 w. Sci Am—June 20, 1903. No. 56107.

"United States."

New Twin Screw Steamship United States. Illustration with brief description of this new passenger and freight steamship of the Scandinavian-American line, for the New York and Copenhagen route. 700 w. Am Shipbuilder—June 18, 1903. No. 55940.

Warships.

The Relative Importance of Offensive and Defensive Qualities in Men-of-War. Sir William Laird Clowes. A criticism of present tendencies in battleship construction, with views at various stages of the work. 6500 w. Page's Mag—May, 1903. No. 56115 B.

The Problem of Building Warships on the Great Lakes. H. C. Sadler. Discusses the possibilities of the lake shipyards and engine works with regard to governmental work, showing that in workmanship, cost of production, and speed in building there is nothing to hinder. The two obstacles being the agreement with Great Britain with regard to building warships on the Lakes, and the difficulty in getting vessels to the coast. Ill. 3300 w. Jour Am Soc of Nav Engrs—May, 1903. No. 55863 H.

Water Cost.

The Cost of the Fresh Water Used on Board of Ocean Steamers (Kosten des an Bord von Seedampfschiffen Verbrauchten Frischwassers). Franz Schneider. A discussion of the cost of fresh water for all purposes, whether distilled from sea water or carried along in tanks. 2000 w. Schiffbau—April 23, 1903. No. 56070 D.

AUOMOBILES.

Commercial Vehicles.

A. C. A. Commercial Vehicle Contest. An account of the first official trial in America of the capabilities of the commercial automobile, the motive powers being steam, gasoline and electricity. Ill. 3500 w. Automobile—May 30, 1903. No. 55552.

Glasgow-London Trials.

The Glasgow to London Non-Stop Trial. Short account of the arrival of the cars in London, with preliminary statements of the various vehicles. Ill. 1500 w. Motor Car Jour—May 23, 1903. No. 55532 A.

Hill Climbing.

Hill-Climbing at Boston, U. S. A. Hugh Dolnar. Brief account of the contest on Commonwealth Ave. hill on April 20th. 700 w. Autocar—May 23, 1903. No. 55531 A.

Lawn Mower.

A Novel Automobile Lawn Mower. Waldon Fawcett. Illustration and brief description of the automobile mower used on the lawn of the United States Capitol. 600 w. Sci Am—June 13, 1903. No. 55-851.

Motor Chair.

The New Motor Chair. Illustration with description of an attractive vehicle for carrying one or two persons in comfort. A novelty shown at the British Auto Ex. 900 w. Sci Am—June 13, 1903. No. 55854.

Motor-Cycles.

What the Motor Cycle Offers. Henry Norman. Considers it the cheapest method of transportation as yet discovered, and destined to have an important effect on industrial and social conditions. 2000 w. World's Work—July, 1903. No. 56-122 C.

Paris--Madrid.

Paris-Madrid. An illustrated article confined mostly to the vehicles used, the regulations, and details of interest to car users. 3000 w. Autocar—May 30, 1903. No. 55671 A.

Paris-Madrid Race. An account of this race between Paris and Bordeaux, with editorial, and many illustrations of vehicles. 9000 w. Auto Jour—May 30, 1903. No. 55669 A.

The Paris-Madrid Automobile Race. which was stopped at Bordeaux because of accidents, with illustrated descriptions of many of the cars. 2800 w. Sci Am—June 20, 1903. No. 56110.

The Paris-Madrid Motor Car Race. A discussion of this race which ended in disaster, with remarks on the instructive features in the designs, and the ability to stand the strain of such speed and the effects upon the industry. 3000 w. Engr, Lond—May 29, 1903. No. 55684 A.

The Paris-Madrid Race. An account of this race so far as run, its sad accidents, and the crowds in attendance. Illustrations of vehicles. 4000 w. Motor-Car Jour—May 30, 1903. No. 55672 A.

Petrol Cars.

The "Continental" Petrol Cars. Illustrates and describes these vehicles, which are made in Paris, and designed to be sold at a moderate price. 1100 w. Auto Jour—May 30, 1903. No. 55670 A.

Racing.

Motor Racing and Motor Records. A Retrospect. Notes on the past history of motor car racing. 1800 w. Sci Am—June 6, 1903. No. 55653.

Steel Rail.

The Automobile and the Railway as Transport Agents. Sylvester Stewart. Shows that the steel rail is even a more important factor than the locomotive in increasing the speed and safety of transit, and argues that the automobile on common roads can never be a serious rival of the railway locomotive. It is an auxiliary for specialized service, but wherever possible will be run on plateways. 3000 w. The Engineering Magazine—July, 1903. No. 56167 B.

Variable Speed.

A Petrol Car Fitted with Variable Speed Friction Gear. An illustrated description of an experimental car fitted with the friction method of transmission. 800 w. Auto Jour—June 13, 1903. No. 55938 A.

Voiturette.

The Humber Voiturette. Brief illustrated description of a small car, two-seated, to be sold for £150. 900 w. Autocar—June 13, 1903. No. 55939 A.

Weller Car.

The Weller Twenty Horsepower Car. Illustrates and describes a British car that has attracted attention. 900 w. Autocar—June 6, 1903. Serial. First part. No. 55778 A.

The Weller Petrol Cars. Illustrates and describes the interesting features of these cars. 2400 w. Auto Jour—June 13, 1903. Serial. First part. No. 55937 A.

HYDRAULICS.

Centrifugal Pumps.

Theory of Centrifugal Pumps and

Fans. Analysis of their action with suggestions for designs. Elmo G. Harris. A study. Ill. 16500 w. Pro Am Soc of Civ Engrs—May, 1903. No. 55771 E.

Flow.

An Experimental Study of the Resistance of the Flow of Water in Pipes. Augustus V. Saph, and Ernest W. Schoder. Presentation and discussion of experimented facts, describing apparatus used, and methods. Tables, plates, &c. 1300 w. Pro Am Soc of Civ Engrs—May, 1903. No. 55770 E.

Hydrodynamics.

The Motions of Fluids Inside Solids of Revolution (Ueber Flüssigkeitsbewegungen in Rotationshohlräumen). Prof. F. Prásil. A mathematical discussion, using cylindrical coordinates, of the motions of fluids inside spaces bounded by surfaces of revolutions, with practical references to the design of turbines. Serial. Part 1. 2000 w. Schweiz Bauzeitung—May 9, 1903. No. 56043 D.

Pumping Plant.

See Civil Engineering, Water Supply.

Resistances.

Some Hydraulic Resistances. John C. Trautwine, 3d. An account of experiments to determine the resistance that water meters offer to the flow of water through them. Ill. 2000 w. Trans Assn of Civ Engrs of Cornell Univ—1903. No. 55927 F.

Slide Rule.

Hydraulic Diagrams and Further Notes Upon the Hazen-Williams Slide Rule. Leonard Metcalf. Gives diagrams and tables showing the relations existing between the new formula and the Chezy formula. 1500 w. Eng Rec—June 20, 1903. No. 55975.

Turbine Flow.

Turbine Flow Recorder. C. M. Allen. An illustrated explanation of a device which automatically records the quantity of water discharged from a turbine with variable gate openings and under variable heads. 1500 w. Trans Am Soc of Mech Engrs—June, 1903. No. 55892.

Water-Wheels.

Tests with a Pelton Wheel. William Campbell Houston. Read before the Inst of Engrs & Shipbuilders in Scotland. An account of a long series of tests of a Pelton wheel working with a pressure of water from 200 lbs to 1000 lbs. per square inch, with an analysis of the results. The objects were to get the power and useful efficiency of the wheel, and to analyze how the water energy was spent. 800 w. Mech Engr—May 30, 1903. Serial. First part. No. 55665 A.

MACHINE WORKS AND FOUNDRIES.

Acceleration.

The Acceleration of Quick Return Mechanisms. W. V. Dunkin. A general discussion of a device much used to produce the slow advance and quick return motion in shaping machines, and the principles involved. 2500 w. Technograph—1902-3. No. 55737 D.

Boring.

Boring a Cylinder—A Shaper Used as a Milling Machine. An illustrated description of an ingenious modification of shop tools to arrange for work of a different character from that for which they were intended. 1000 w. Am Mach—June 25, 1903. No. 56140.

Boring Mill.

Description of Sixty-Foot Vertical Boring and Turning Mill Designed by John Riddell for General Electric Co. John Riddell. Ill. 2300 w. Trans Am Soc of Mech Engrs—June, 1903. No. 55884.

Brass Castings.

A New and Sanitary Process of Pouring Brass in Casting. Illustrates and describes the apparatus devised by W. Lynes, which has proved successful in protecting the workmen from the noxious fumes and also saves a valuable by-product. 1000 w. Sic Am—June 13, 1903. No. 55852.

Methods of Gating and Molding Brass Castings. C. Vickers. Illustrates and describes methods that have given good results. 1600 w. Am Mach—June 25, 1903. No. 56143.

Brass Working.

The Working of Brass and Similar Alloys in the Hot State, and the Dick Squirting Process (Die Verarbeitung des Messings und Verwandter Legierungen auf Warmem Wege und das Warmpressverfahren von Alexander Dick). A. Hilpert. An illustrated paper on the working of brass, high in zinc and brass alloys while hot, and a description of the Dick process for squirting hot metal through dies. 2500 w. Zeitschr d Ver Deutscher Ing—June 6, 1903. No. 56080 D.

Castings.

An Australian Statue. John F. Buchanan. Gives an illustration of the design and explains the process of casting in detail. 1700 w. Foundry—June, 1903. No. 55761.

Change Gears.

The Evolution of the Change Gear. Oscar E. Perrigo. A study of the United States patents on the lathe change gear devices. Deals solely with devices designed for screw cutting. Ill. 6200 w. Mach, N Y—June, 1903. Serial. First part. No. 55615 C.

Dies.

Dies for Sheet Metal Bag Clasps. Joseph V. Woodworth. Illustrates and describes the use of these dies. 1000 w. Am Mach—June 11, 1903. No. 55825.

A Triple-Action Die for Blanking, Drawing and Embossing an Aluminum Shell in One Operation. Joseph V. Woodworth. Illustrated description. 1000 w. Am Mach—June 18, 1903. No. 55958.

Discussions.

Topical Discussions and Notes of Experience. Includes a short description of a milling machine attachment for cutting worms; the adoption of a standard form of boiler for testing the calorific value of fuels is suggested, and a new form of flexible metallic tubing is described. Ill. 1500 w. Trans Am Soc of Mech Engrs—June, 1903. No. 55909.

Expert Service.

The Metallurgical Engineer in the Foundry. Henry Sonther. Showing that there is wisdom and economy in employing a good metallurgical engineer. 2500 w. Jour Am Found Assn—June, 1903. No. 55751.

Fitting.

Fits and Fitting. Stanley H. Moore. An investigation of recent practice in forcing shrinking, driving and running fits, and limits for limit gauges. 3000 w. Trans Amer Soc of Mech Engrs—June, 1903. No. 55890.

Foundry Iron.

Blast Furnace Conditions Affecting the Chemical Composition of Foundry Iron. W. Walley Davis. Defines some of the blast furnace conditions that contribute to, or cause changes in the chemical composition of iron. 2800 w. Jour Am Found Assn—June, 1903. No. 55752.

Foundry Management.

Foundry Management. Edward Kirk. Describes conditions representing the management of fully half the foundries, and discusses improvements. 5200 w. Foundry—June, 1903. No. 55762.

Foundry Operation.

The Continuous Operation of the Iron Foundry. John C. Knoeppel. Views from the standpoint of a practical molder and foundryman, discussing features that should be considered. 1600 w. Jour Am Found Assn—June, 1903. No. 55756.

Gauge.

A Worm and Spiral Gear Tooth Gauge. Ernest J. Lees. Illustrates and describes the use of this thread tool gauge. 600 w. Am Mach—June 18, 1903. No. 55960.

High-Speed Steel.

See Mechanical Engineering, Materials of Construction.

Iron Mixtures.

A Simple Device for Ascertaining the Average Silicon in an iron mixture. Arthur W. Walker. Illustration and brief explanation of the working of a device consisting of a balanced scale. 400 w. Jour Am Found Assn—June, 1903. No. 55746.

Jig Work.

Accuracy in Jig and Fixture Work. J. M. Stabel. Illustrates and discusses a special indicator designed by the writer, for setting the buttons in perfect alignment with the milling machine spindle, and its use. 1000 w. Am Mach—June 4, 1903. No. 55639.

Lathes.

Some Lathe Shop Notes. Describes the methods of testing these machines as used by the F. E. Reed Co., of Worcester. Ill. 2000 w. Am Mach—June 4, 1903. No. 55637.

The Inefficiency of the Ordinary Lathe for High Speed Cutting. H. M. Norris. Read before the Cincinnati Metal Trades Assn. Discussion with an account of tests made on a new high speed lathe. Ill. 3000 w. Ir Age—June 11, 1903. No. 55-720.

Milling Machine.

Milling Machine Methods. Illustrations with descriptions of operations in ordinary, every-day work. Gives also particulars of the material used, and other details of interest. 1400 w. Engr, Lond—May 22, 1903. No. 55544 A.

Molding.

Permanent Molds. James A. Murphy. Remarks on loam molding, with suggestions and illustrations. 800 w. Jour Am Found Assn—June, 1903. No. 55749.

Molding Machines.

The Molding Machine. S. H. Stupakoff. An illustrated discussion of these machines and what they are designed to accomplish. 4000 w. Jour Am Found Assn—June, 1903. No. 55754.

Molding Machines. Edward B. Gilmour. Remarks on the advantages and disadvantages of these machines, with an illustrated description of a stripping plate drop pattern machine and the castings made with it. 900 w. Jour Am Found Assn—June, 1903. No. 55747.

Pig-Iron Casting.

See Mining and Metallurgy, Iron and Steel.

Rail Re-Rolling.

The Renewal of Worn Steel Rails. N. L. Hurd. Describes fully the McKenna process of re-rolling worn steel rails. 1600 w. Wisconsin Engr—May, 1903. No. 56-125 D.

Screw Threads.

Measuring External Screw Thread Diameters. Walter Cantelo. Gives sketches, formulas and tables, worked out by the writer, so that by using ordinary micrometer calipers and wire of the diameter called for in the table, the standard threads can be compared with the figures given. 1200 w. Am Mach—June 25, 1903. No. 56142.

Sheet Iron.

The Manufacture of Sheet-Iron used in Dynamo Construction (Die Herstellung der im Dynamobau Gebrauchten Bleche). K. Frucht. An illustrated description of the machinery for cutting, stamping, slotting and performing other operations on iron sheets for armature cores and other purposes in dynamo construction. 3000 w. Zeitschr d Ver Deutscher Ing—May 30, 1903. No. 56077 D.

Sheet Metal.

A Punching and Curling Job. Joseph V. Woodworth. Illustrated description of methods of producing sheet metal parts of unusual shape. 1100 w. Am Mach—June 4, 1903. No. 55640.

Shop Construction.

New Shops of the American Turret Lathe Mfg. Co. Illustrates and describes the interesting features in shop construction. 1500 w. Mach, N Y—June, 1903. No. 55616 C.

The Machine Shop and Foundry of the Pencoyd Iron Works. Begins an illustrated description of these works, remarkable for their great strength—the construction is a steel frame with curtain walls of concrete filled in between the columns——also for the crane arrangements. 1200 w. Ill. Am Mach—June 25, 1903. Serial. 1st part. No. 56139.

Shop Equipment.

The Equipment of Machine Shops. Joseph Horner. Considers questions that have to be settled in the purchase of machinery and plant. Ill. 4500 w. Cassier's Mag—June, 1903. No. 55919 B.

The Shops of the E. W. Bliss Company, Brooklyn, New York. Joseph V. Woodworth. An illustrated detailed description of a large and finely equipped machine manufacturing plant. 4000 w. Ir Trd Rev—June 4, 1903. No. 55625.

See also Railway Engineering, Permanent Way and Buildings.

Springs.

Springs and Their Use. Ivar Kirkegaard. Remarks on the extensive use of springs, and discusses the use and manufacture of furniture springs, spiral springs, hot wound springs, jig springs, and flat wire springs. Ill. 5500 w. Ir Age—June 4, 1903. No. 55597.

MATERIALS OF CONSTRUCTION.

Alloys.

Influence of Casting Temperature on Properties of Alloys. Percy Longmuir. Abstract of a paper read before the Ir. and St. Inst. An account of researches with industrial brasses, describing methods and considering results. 2500 w. Mech Engr—May 30, 1903. No. 55662 A.

Alluminum Alloys.

Some Aluminum Alloys and Their Uses. Walter J. May. Directions for the making of aluminum alloys with strengths equal to cast iron or steel, and at a cost no more expensive than brass. 600 w. Prac Engr—June 5, 1903. No. 55725 A.

Decay of Metals.

The Decay of Metals. J. T. Milton. Abstract of a paper read before the Inst. of Civ. Engrs. Gives examples of the decay referred to, considering the causes. 1700 w. Elec Engr, Lond—May 22, 1903. No. 55536 A.

Emery Wheels.

The Bursting of Emery Wheels. Charles H. Benjamin. Gives illustrations and tabulated results of a number of tests made on wheels of various makes, bought in the open market. 600 w. Trans Am Soc of Mech Engrs—June, 1903. No. 55886.

High-Speed Steel.

The Capabilities of High Speed Steel. William Lodge. Read before the Cincinnati Metal Trds. Assn. Gives table showing results in actual practice, with remarks on use of this steel. 1300 w. Am Mach—June 11, 1903. No. 55824.

Malleable Iron.

Malleable Cast Iron. Dr. Richard Moldenke. On the properties, composition and structure, with directions for making malleable castings. 3200 w. Jour Am Found Assn—June, 1903. No. 55753.

Metallic Packings.

Metallic Packings.—Principles of Design Essential for Successful Development. Charles Longstreth. Discusses the purposes and requisites of a successful packing, importance of care in design, etc. 3800 w. Jour Am Soc of Nav Engrs—May, 1903. No. 55860 H.

Micro-Structure.

Notes on the Micro-Structure of Cast Iron. Percy Longmuir. Discusses features of profitable interest revealed by microscopic examination. Ill. 800 w. Jour Am Found Assn—June, 1903. No. 55748.

Petrol.

How to Solve the Petrol Problem. A lesson from France. Comments on the better quality of petrol sold in France, and explains it as due mainly to the competition of alcohol. 2200 w. Autocar—June 6, 1903. No. 55777 A.

Piston Strength.

See Mechanical Engineering, Steam Engineering.

Strains.

Strains Produced by Excessive Tightening of Nuts. A. Bement. Calls attention to the fact that materials are frequently unduly strained during the process of assembling, by the excessive tightening of nuts, giving an example. 300 w. Trans Am Soc of Mech Engrs—June, 1903. No. 55903.

Tool Wood.

Machine Tool and General Tool Woods of the Philippines. Describes tough woods adaptable for service in machine and general lines of modern tools. Ill. 1200 w. Mod Mach—June, 1903. No. 55689.

MEASUREMENT.

Anglemeter.

An Indicating Anglemeter. C. E. Sargent. Illustrated description of a device designed to determine at sight the maximum variation in engine flywheels. Its chief use is in running alternators in parallel. 1000 w. Trans Am Soc of Mech Engrs—June, 1903. No. 55896.

Connecting Rods.

Investigation of the Stresses in a Connecting Rod, Due to the Inertia Forces. J. H. Wallace. Describes the investigation of such stresses in a particular case. Ill. 1200 w. Technograph—1902-3. No. 55741 D.

Dynamometer.

A New Apparatus for Determining the Resistance of Road Vehicles to Traction. Illustrates and describes the new dynamometer devised by Prof. Hele-Shaw for experimental investigation concerning the resistance of road vehicles to traction. 1700 w. Sci Am—June 6, 1903. No. 55654.

Fan-Testing.

A Dynamometer and Revolution Counter for Fan Testing. D. W. Taylor. Illustrated description of an instrument designed and built for the purpose of making experimental investigation of the capacity and efficiency of ventilating fans which has been found quite satisfactory. 2000 w. Am Mach—June 11, 1903. No. 55823.

Hoisting Hooks.

Some Data on Hoisting Hooks. John L. Bacon. Gives results of some tests made on the strength of hooks bent out of round stock, and compares them with tests on those shaped according to Towne's Formula, giving also the effect of case hardening. Ill. 700 w. Trans Am Soc of Mech Engrs—June, 1903. No. 55904.

Levels.

Hydrostatics and Spirit Levels. R. P. King. On methods of testing levels and using them, determining the probable error, etc. Ill. 1000 w. Am Mach—June 25, 1903. No. 56141.

Oils.

Simple Methods of Testing Oils. J. K. Nye. Considers methods of determining the viscosity, gravity, and fire test. 2000 w. Marine Engng—June, 1903. No. 55609 C.

A Comparative Oil Test. William F. Parish, Jr. Describes tests made for showing the relative efficiency of two different grades of oil made for the same kind of service. 1400 w. Trans Am Soc of Mech Engrs—June, 1903. No. 55906.

Plates.

Comparative Tests of Plain and Riveted Plates. E. J. McCaustland. Results of tests made to determine the relation existing between plates and shapes of structural steel, and the same properties of plates and shapes used collectively in built-up members. 1500 w. Trans Assn of Civ Engrs of Cornell Univ—1903. No. 55925 F.

Wire Rope.

The Strain in the Core Wire of Strands (Die Beanspruchung der Litzen-Seelendrähte). Julius Divis. An account of experiments on the strength of wire ropes, with particular reference to the part played by the center or core wire. Diagrams. Serial. 2 Parts. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 30, June 6, 1903. No. 56036 D.

POWER AND TRANSMISSION.

Accidents.

Accidents Due to Combustion Within Air Compressors. Editorial discussion of points to be considered to avoid accidents. Called out by Dr. Ledoux's paper before the Am. Inst. of Min. Engrs. 600 w. Compressed Air—June, 1903. No. 56118.

Air Compressors.

Compressed Air for Pumps. Frank Richards. Some remarks on means of determining the sizes of air compressors for operating pumps. 600 w. Am Mach—June 4, 1903. No. 55638.

Flywheels.

Flywheels, Their Purpose, Principle and Design—Calculation for Speed Variation. William Burlingham. Gives an idea of some of the difficulties in the work, and the reasons for the adoption of the varying types. Ill. 3000 w. Mach, N. Y.—June, 1903. No. 55617 C.

Elevators.

Tests of an Hydraulic Elevator System. Reginald Pelham Bolton. Describes the trial of an elevator system installed in a new department store in New York. 1800 w. Trans Am Soc of Mech Engrs—June, 1903. No. 55889.

Hoisting.

Tests of the Efficiency of Hoisting Tackle. S. L. Wonson. An account of tests recently carried out by the American Bridge Co. of New York, using its standard types of blocks, with various combinations of manila and wire rope. Tabulated results are given. 800 w. Eng News—June 11, 1903. No. 55832.

Ore Handling.

Gigantic Ore-Handling Machinery. W. Frank McClure. An account of important innovations in connection with the ore-handling industry, with illustrations of ore-unloaders. 1200 w. Sci Am—June 20, 1903. No. 56109.

Rubber Belting.

Hints on Rubber Belting. W. H. Kritzer. Suggestions for the selection, care, and running of these belts. 700 w. Min & Sci Pr—May 30, 1903. No. 55701.

SPECIAL MOTORS.

Alcohol Motors.

French Research on Alcohol Motors. Capt. C. C. Longridge. Indicates the line of reasoning in the report of M. Sorel in regard to certain points. Considers the fuel employed, effects of the fuel on the motor, analysis of the exhaust gases, quantity of air required for combustion, and carburation. 1700 w. Engr, Lond—June 5, 1903. No. 55802 A.

Binary Engine.

Sulphur-Dioxide and the Binary Engine. R. H. Thurston. A study of the physical properties of sulphur-dioxide and the economical advance claimed for the series-vapor engine of Prof. Josse. 2700 w. Jour Fr Inst—June, 1903. No. 55736 D.

Blowing Engines.

Blast-Furnace Gas Engines and Steam Engines. H. G. Scott. Facts given in connection with the discussion of a paper by Cecil A. Cochrane, at a meeting of the Cleveland Inst. of Engrs. Compares the efficiency. 3000 w. Engng—May 22, 1903. No. 55542 A.

Gas-Driven Blowing Engine (Delamere-Deboutteville & Cockerill System). Illustrated description of 750 h. p. blowing engines driven by blast-furnace gas, and of the working. 1800 w. Engng—May 22, 1903. No. 55540 A.

Gas Engines.

Current Practice in Gas Engine Design. H. Lee Koenig and G. W. Rice. Investigations based on data of some eighty engines. 3800 w. Sib Jour of Engng—June, 1903. No. 55758 C.

The Nuremberg Double-Acting Tandem Gas Engines. Reviews the different methods adopted by the various makers to obtain great mechanical power from one single engine, and gives drawings showing the construction of the new type of engine named. 2400 w. Ir & Coal Trds Rev—June 12, 1903. No. 55942 A.

Gas-Engine Tests.

A Method of Testing Gas Engines. E. C. Oliver. An illustrated paper describing methods and apparatus in use in some tests on a 10 h. p. Otto gas-engine to determine the distribution of the heat supply by the fuel, and the temperature at various points in the cycle, giving the results of the heat tests. 3500 w. Trans Am Soc of Mech Engrs—June, 1903. No. 55899.

Tests of a Twelve-Horse-Power Gas Engine to Determine the Effects of Changes in Speed, Load, Point of Ignition, Ratio of Gas to Air, and Jacket Temperature. C. H. Robertson. A record of tests at Purdue Univ. continuing over a period of six years. Full description, with conclusions. Ill. 6500 w. Trans Am Soc of Mech Engrs—June, 1903. No. 55885 C.

Kerosene Engine.

Performance of an Internal Combustion Engine Using Kerosene and Gasoline as Fuel. H. F. Halladay and G. O. Hodge. Reports a series of investigations made to determine the economic performance of a standard engine of the Otto type. 5200 w. Trans Am Soc of Mech Engrs—June, 1903. No. 55897 D.

Oil Engine.

The Ostergren Fuel Oil Engine. Illustrates a 50-h. p. stationary engine, explaining its operation, and stating the general merits of the invention. 1200 w. Sci Am—June 6, 1903. No. 55651.

Petrol Engines.

The Blake Petrol Engines. An illustrated description of an engine of 40 to 50 nominal h. p., designed with a view to rendering it suitable for a variety of purposes. 2500 w. Auto Jour—June 6, 1903. No. 55779 A.

STEAM ENGINEERING.

Balancing Engines.

See Marine and Naval Engineering.

Boilers.

Boiler and Furnace Efficiencies. A. Bement. Read before the Nat. Elec. Lgt. Assn. Discussing some features of the performance of modern standard apparatus, considering two types of boilers, two furnaces, and one stoker. 5000 w. Elec Rev, N. Y.—June 13, 1903. No. 55828.

The Naval Boiler Question in France. Discussing the relative merits of large and small size tubes for boilers of cruisers and battleships. An official order of the French Minister of Marine. 3000 w. Jour Am Soc of Nav Engrs—May, 1903. No. 55862 H.

A New Type of Water-Tube Boiler. Translation from an article on the "Water-Tube Boilers for Merchant Ships," by Constructing-Engineer Benetsch. An illustrated description of the Schüette combined Scotch and water-tube boiler. It is of the oval fire-tube type, with small-tube water-tubes behind the combustion chamber. 1800 w. Marine Engng—June, 1903. No. 55607 C.

The Moore Vertical Water-Tube Boiler. States the considerations that led to the design of boiler and boiler furnace patented by Enos L. Moore, giving an illustrated description. 1600 w. Ir Age—June 25, 1903. No. 56138.

The Experiment Boiler of the Ohio State University, with Results of Some Trials. E. A. Hitchcock. Outlines the details and installation of an experimental boiler with its accessories, and gives results of various trial running. Ill. 9000 w. Trans Am Soc of Mech Engrs—June, 1903. No. 55907 D.

Boiler Tubes.

Seamless Steel Boiler Tubes.—Their Limited Endurance a Menace to Naval Efficiency. Lieut. Newton Mansfield. Discusses the endurance of iron and mild-steel tubes, nickel steel tubes and cold-drawn steel tubes, etc. Ill. 5000 w. Jour Am Soc of Nav Engrs—May, 1903. No. 55861 H.

Compound-Engine Test.

Water and Heat Consumption of a Compound Engine at Various Powers. D. S. Jacobus. Describes test of the Rice & Sargent horizontal cross-compound type, provided with a Corliss valve gear. Gives method of testing, conditions, and results. 1400 w. Trans Am Soc of Mech Engrs—June, 1903. No. 55905.

Condensers.

The Condensing Plant of the New York Rapid Transit Power House. An illustrated detailed description of this interesting plant. 1800 w. Power—June, 1903. No. 55558 C.

The Self-Cooling Condenser. Thomas L. Wilkinson. A contribution to steam economics. 1200 w. Min Rept—May 28, 1903. Serial. 1st part. No. 55550.

Distilling Apparatus.

The Goss Series Distilling Apparatus. Charles Ducas. An illustrated description of an apparatus by which it is practicable to obtain between 70 and 80 lbs. of water per lb. of coal burned. 2800 w. R R Gaz—June 19, 1903. No. 55977.

Feed Water.

The Purification of Feed Water. J. B. Greer. Reviews the development of water purification in the United States. General discussion. 8000 w. Ry Club of Pittsburgh—Feb., 1903. No. 55806 C.

Fuel.

Fuel: What We Don't Know About It. Edward Atkinson. A discussion of the use of peat, turf, briquettes from culm, and various kinds of fuel other than coal, with information relating to their formation. General discusion follows. 8400 w. Jour N E Water Wks Assn—June, 1903. No. 55956 F.

Governor Drives.

Positive Governor Drives for Corliss Engines. A. H. Eldredge. A brief illustrated article strongly advocating the use of gearing or sprocket and chain to replace belts for governor drive. 600 w. Trans Am Soc of Mech Engrs—June, 1903. No. 55891.

Jacketing.

Performance of an Engine Designed for Maximum Jacketing Effects. W. F. M. Goss. Describes a new design made to secure an arrangement by means of which the cylinder walls can at all times be maintained at a temperature closely approaching that of the initial steam. Reports tests. Ill. 1500 w. R R Gaz—June 19, 1903. No. 55981.

Liquid Fuel.

Liquid Fuel for Power Purposes. Arthur L. Williston. A discussion of the economic side of the question, showing when and where it will pay to substitute oil for coal; gives also a clear summary of the present and possible future output of fuel oil. Illustrated by charts. 4500 w. The Engineering Magazine—July, 1903. No. 56174 B.

Marine Engines.

See Marine and Naval Engineering.

Oil Extractor.

The Hot Well as an Oil Extractor. A. H. Eldredge. A brief illustrated description of the details and action of the hot-well and its use for the separation of oil from the water from the cylinder which passes through it. 4500 w. Trans Am Soc of Mech Engrs—June, 1903. No. 55888.

Piston Strength.

The Strength of Pistons of Steam Engines (Conditions de Résistance des Pistons des Machines à Vapeur). M. Codron. An extensive mathematical discussion of the different stresses and strains in pistons of steam engines. Diagrams. Serial. Part 1. 7500 w. Rev de Mécanique—May 31, 1903. No. 56166 E + F.

Progress.

Recent Progress in Steam Engines (Quelques Progrès Récemment Réalisés dans les Machines à Vapeur). P. Arrachart. A general review, with particular reference to the Paris and Düsseldorf Expositions, and illustrated descriptions of improvements and new features in steam engines and of steam turbines. 1 Plate. 8000 w. Mem Soc Ing Civils de France —April, 1903. No. 56160 G.

Pumping Engines.

The Heisler Compensating Gear for Direct-Acting Pumping Engines. Notes briefly the methods of compensating used in various pumps, and gives an illustrated detailed description of the method devised by Chas. L. Heisler. It comprises essentially a link connection between the two piston rods of a duplex or a compound pump. 3800 w. Eng News—June 4, 1903. No. 55629.

See also Civil Engineering, Water Supply.

Reciprocating Engines.

A Study of the Mechanical Operation of Reciprocating Engines (Contribution à l'Etude du Fonctionnement Mécanique des Machines Alternatives). R. Lelong. A mathematical and graphical discussion of the laws underlying the operation of reciprocating engines, with a view to indicating the directions for improvements. Diagrams. Serial. Part 1. 8000 w. Rev de Mécanique—May 31, 1903. No. 56-165 E + F.

Steam.

The Expansion, Separation, and Compression of Wet Steam. Robert H. Smith. A study in thermo-dynamics suggested by the paper read by Prof. W. H. Watkinson in Glasgow, on Feb. 17, 1903. 3500 w. Engr, Lond—May 29, 1903. No. 55681 A.

Steam Engines.

Corliss Engines. George C. Phillips. A full illustrated account of this great invention, with descriptions of the types made by the numerous manufacturers, and much information of interest. 3700 w. Engr, U S A—June 15, 1903. No. 55961 C.

High-Speed Engines. Charles T. Porter. Discusses the development and probable future changes of these engines, and gives illustrated descriptions of many types, and of matters relating to their operation. 30000 w. Engr, U S A—June 15, 1903. No. 55963 C.

Low and Medium-Speed Engines. J. W. Thompson. An illustrated detailed description of slow and medium rotative speeds; the characteristics of the various styles; their adjustment, etc. 1700 w. Engr, U S A—June 15, 1903. No. 55962 C.

Continental Engine Construction. Two articles presenting some of the leading features of heavy stationary engine construction for electric traction, lighting, and power transmission. 4500 w. Engr, Lond —May 29 and June 5, 1903. Serial. 2 parts. No. 55680 each A.

Lentz Steam Engines for Driving Electric Generators (Ueber Dampfmaschinen für Elektrische Betriebe, Bauart Lentz). Fr. Freytag. A paper before the Elektrotechnischer Verein, giving an illustrated description of the Lentz steam engines and their piston-valve gear, particularly adapted to the driving of electric generators. 3000 w. Elektrotech Zeitschr—June 11, 1903. No. 56098 B.

Steam Heating.

The Thermograde System of Steam Heating. Walter E. Barnes. An illustrated description of this system which claims to have overcome some of the disadvantages of other systems, and to have advantages of its own. 2400 w. Harvard Engng Jour—May, 1903. No. 55732 D.

Steam Turbines.

The Steam Turbine from an Operating Standpoint. Frederick A. Waldron. Description and test of a 400 k. w. turbo-generator at the Yale & Towne Works. Treats the subject not only from the operating standpoint, but includes data from the boiler room to the motor pulley. Ill. 4500 w. Trans Am Soc of Mech Engrs —June, 1903. No. 55895 C.

Testing Methods of the Westinghouse Machine Co. for Steam Turbines. Edwin Yawger. Read before the Cleveland Elec. Club. Explains the careful methods of this company, the systematic testing, and related matters. Ill. General discussion. 6500 w. Engr, U S A—June 1, 1903. No. 55636 C.

Exhaust-Steam Turbines. Editorial review of the investigations of Prof. A. Rateau and his recently developed system, giving an illustrated description of a plant in working at the Bruay coal mines (Pas-de-Calais). 2200 w. Engng—June 5, 1903. No. 55791 A.

Stokers.

Mechanical Stokers. Edwin Fitts. Explains the combination of fuel in a furnace, different forms of furnaces, outlines the history of mechanical stoking, giving illustrations of various types. 3300 w. Pro Engrs' Soc of W Penn—April, 1903. No. 55768 D.

Superheating.

The Question of Superheated Steam in Locomotives (Zur Frage der Anwendung der Dampfüberhitzung im Lokomotivbetriebe). Otto Berner. A systematical discussion of tests, by different investigators, on the use of superheated steam in locomotives. Tables and illustrations. Serial. 2 Parts. 10000 w. Zeitschr d Ver Deutscher Ing—May 23 and 30, 1903. No. 56074 each D.

Superheated Steam in Locomotive Service. The first of a series of articles presenting an elementary view of the problem, to be followed by a discussion of the development of the practice in America and Europe, with special attention to the Schmidt system. 2000 w. R R Gaz—June 5, 1903. Serial. 1st part. No. 55660

Test of Superheated Steam. Prof. M. Schröter. A report of trials made at Ghent, on a horizontal tandem engine, driving a continuous current dynamo, to examine the economy at different degrees of cut-off and at different temperatures of superheating. 2700 w. Power—June, 1903. No. 55559 C.

Thermodynamics.

Graphics of Thermodynamics: A Comparative Study. J. L. Bates and E. C. Welborn. The cycles of the Carnot, the Otto, the Brayton, the Ericsson and the Sterling have been computed, and under such assumptions that when plotted the resulting cycles would superimpose and give to the eye a suggestion of relative characteristics. 1200 w. Sib Jour of Engng—June, 1903. No. 55759 C.

MISCELLANY.

Acetylene Blowpipe.

The Working of Metals With the Oxygen-Acetylene Blowpipe (La Soudure Autogène des Métaux. Soudure au Chalumeau Oxyacétylénique). André Binet. An illustrated description of a blowpipe using acetylene and oxygen for conveniently producing very high temperatures, and its applications in metal working. 2000 w. Génie Civil—May 23, 1903. No. 56153 D.

Aeronautics.

The Problem of Aerial Navigation (Ueber die Versuche zur Lösung des Problemes der Luftschiffahrt). Ferd. Gerstner. Paper discussing the problems of aerial navigation and the different classes of air ships and balloons. Diagrams and tables. 5000 w. Zeitschr d Oesterr Ing u Arch Vereines—April 10, 1903. No. 56012 B.

The Tetrahedral Principle in Kite Structure. Alexander Graham Bell. Reprinted from the *Nat. Geog. Mag.* An illustrated account of work in this field, especially showing the advantages of the tetrahedral principle. 4500 w. Sci Am Sup—June 13, 1903. No. 55856.

The Kite Principle in Aerial Navigation. Garrett P. Serviss, Jr. A discussion of the mechanical principles involved as shown by kites, and their application to aerial navigation. 1600 w. Sci Am —June 27, 1903. No. 56148.

Experiments Preliminary to Crossing the Sahara Desert by Balloon (Récents Sondages de l'Atmosphère pour la Traversée du Sahara en Ballon). M. Dibos. Observations on the winds of the Sahara, and description of trial balloons and the flight of one from Gabes, in Tunis, to a point in Algeria, 600 kilometers distant. 4000 w. Mem Soc Ing Civils de France —April, 1903. No. 56159 G.

Agricultural Machinery.

Agricultural Engineering. An extended illustrated description of British agricultural machinery for the colonies. Illustrates and describes in detail the various implements. 13500 w. Engr, Lond—June 12, 1903. (Supplement.) No. 55946 A.

Agricultural Machinery in New Zealand. An account of the progress in the use and also in the manufacture of agricultural machinery. 1800 w. Engr, Lond —June 12, 1903. No. 55944 A.

Construction Machinery.

Construction Machinery at the Düsseldorf Exposition, 1902 (Die Baumaschinen der Düsseldorfer Ausstellung, 1902). W. Hübbe. An illustrated account of concrete mixers, elevators, pile drivers, excavators and other machines for building operations. 3000 w. Zeitschr d Oesterr Ing u Arch Vereines—May 8, 1903. No. 56-020 B.

Drawing Rooms.

Drawing Office Equipment. John McGeorge. Discusses light, natural and artificial, space allotted to each man, types of drafting boards, sanitary arrangements, blue-print facilities, etc. 3000 w. Ill. Trans Am Soc of Mech Engrs—June, 1903. No. 55902.

Düsseldorf Exposition.

A Brief Account of the Düsseldorf Exposition (Kurze Mitteilungen von der Düsseldorfer Ausstellung). Berthold Braun. An address, giving an account of some of the mechanical features of the Düsseldorf Exposition of 1902, with illustrations. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—May 1, 1903. No. 56017 B.

Gear Drafting.

An Instrument for Drawing the Teeth of Gear Wheels (Zahnkurven-Zeichenmaschine). Franz Haas. An illustrated description of a convenient instrument, like a beam compass, for drawing teeth which have practically correct forms. 2500 w. Zeitschr d Ver Deutscher Ing—May 16, 1903. No. 56073 D.

Heating.

European Heating Apparatus. Charles F. Hauss. Brief illustrated descriptions of systems in use. 3800 w. Met Work—June 13, 1903. No. 55810.

Test of a Direct-Connected 8-Foot Fan and Engine. E. S. Farwell. Describes a test made to obtain reliable data which would serve as a guide in the selection of size of apparatus for a given case of heating. The methods of conducting the test are outlined and the details discussed. Ill. 3000 w. Trans Am Soc of Mech Engrs—June, 1903. No. 55900.

See also Mechanical Engineering, Steam Engineering.

Hydroscope.

Pino's Hydroscope and the Efforts of His Predecessors. Dr. Carlo Iberti. The present article describes an English and an American instrument of like style to Pino's hydroscope, which will be described in later numbers. Ill. 1200 w. Elec Engr, Lond—May 29, 1903. Serial. 1st part. No. 55677 A.

Laundry Machinery.

Some Present Requirements in Laundry Machinery. Henry Waring. A systematic study of the requirements of a large steam laundry. 4000 w. Engng—May 29, 1903. No. 55685 A.

Liquid Air.

Practical Liquid Air Possibilities. Dr. Carl von Linde. Extracts from an address before the Ice and Cold Storage Assn., of London, considering its use for refrigeration and power. 3200 w. Cassier's Mag—June, 1903. No. 55918 B.

Lubrication.

Friction on Lubricated Surfaces. F. A. McKay. Prize essay. Studies the effect of pressure, velocity, and temperature on friction: also lubricants and methods of testing them. 3800 w. Can Engr—June, 1903. No. 55695.

The Zöller Lubrication System (Zöller's Zentral-Schmiervorrichtung). W. K. Macka. An illustrated description of a system of lubrication in which the oil is in holes bored through the centers of shafts and journals and is conducted to the bearings by centrifugal action. 1 Plate. 1600 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 9, 1903. No. 56032 D.

Oiling System. P. E. Moock. Discusses the essentials of a successful oiling system, and gives information in regard to an inexpensive system recommended. 1500 w. Power—June, 1903. No. 55560 C.

See also Mechanical Engineering, Measurement.

Mechanical Plant.

Mechanical Plant of the Farmers' Deposit National Bank Building, at Pittsburg. Describes this fine 24-story office building, and the plants for lighting and for furnishing power for the elevators. Ill. 5500 w. Engr, U S A—June 1, 1903. No. 55635 C.

Plumbing.

House Drainage. A. B. Raymond. From a paper read before the Mich. Engng. Soc. Shows where the danger lies in present practice and the forms of construction employed to prevent danger. 2200 w. Dom Engng—June 25, 1903. No. 56368.

Problems.

Some Unsolved Problems in Engineering. W. H. Maw. Abstract of the eleventh "James Forrest" lecture at the Inst. of Civ. Engrs. Devoted principally to heat engines, and to strength of materials, and showing the desirability of engineers and physicists working together in investigations of engineering problems. 4800 w. Elect'n, Lond—June 19, 1903. No. 56339 A.

Refrigeration.

Mechanical Refrigeration. Otto Luhr. Explains process and gives formulas for capacity, efficiency, etc. 3500 w. Ice & Refrig—June, 1903. No. 55604 C.

Smoke Prevention.

Burning Illinois Coal without Smoke. L. P. Breckenridge. From a paper read before the Commercial Club of Chicago. Discusses the lines to be followed in the construction of new plants for burning bituminous coals, and what can be done to improve existing plants. 2000 w. Eng News—June 11, 1903. No. 55831.

Speed Indicator.

The Karlik Tachygraph for Winding Engines. H. Hubert, in *Revue Universelle des Mines*. Illustrated description of a speed-indicator for colliery engines, which is extensively used in Austria. 500 w. Col Guard—June 5, 1903. No. 55788 A.

Watervliet Arsenal.

United States Army Gun Factory, Watervliet Arsenal, N. Y. John M. B. Scheele. General description, with a brief account of the shops, calling attention to interesting details. 1200 w. Trans Am Soc of Mech Engrs—June, 1903. No. 55887.

Wire Guns.

Wire-Bound Ordnance. Charles Berthon. Illustrates and describes the details of construction of wire-wound guns, giving a brief review of the system. 3500 w. Feilden's Mag—June, 1903. No. 55913 B.

COAL AND COKE.

Analysis.

The Distinguishing Characteristics of Brown Coal and Hard Coal (Zur Unterscheidung von Braun- und Steinkohle). Ed. Donath and Hugo Ditz. A discussion of the chemical and physical difference of coals and methods of determining them. 3000 w. Oesterr Zeitschr f Berg u Hüttenwesen—June 6, 1903. No. 56-037 D.

British Trade.

The Growth and Direction of Our Foreign Trade in Coal During the Last Half Century. D. A. Thomas. Read before the Royal Statistical Soc. A study of the growth, character and direction of British trade in coal during the second half of the nineteenth century. 15000 w. Ir & Coal Trds Rev—May 22 and 29, 1903. Serial. 2 parts. No. 55547 each A.

Charcoal.

A New Charcoal Cooling Process. Bernard Zwillinger. A description of a process of cooling by the cold gases which are produced during the distillation of wood under exclusion of air, with the advantages claimed. 4300 w. Ir Age—June 11, 1903. No. 55721.

Coal Cutting.

Coal-Cutting by Machinery. Owen Hughes. Read before the Manchester Geol. & Min. Soc. A record of actual operations, under varying conditions, extending over a considerable period. 6800 w. Col Guard—June 12, 1903. No. 55870 A.

On Coal-Cutting by Machinery. Owen Hughes. Read before the Manchester Geol. & Min. Soc. Describes the system adopted with the machines, the timbering, average results of working, cost, and related matter. 6800 w. Ir & Coal Trds Rev—June 5, 1903. No. 55805 A.

The Chain and the Pick Machines. H. S. Johnson. A comparison of the two types of coal-cutters from the standpoint of an advocate of chain machines. Ill. 1800 w. Mines & Min—June, 1903. No. 55571 C.

Coal Storage.

A Circular Storage System for 50,000 Tons of Coal. Illustrates and describes an interesting plant recently installed at the works of the Maryland Steel Co. for the handling and storage of soft coal. 800 w. Ir Age—June 4, 1903. No. 55596.

Coke.

Comparative Test of Beehive and Retort Coke. E. A. Uehling. A study of their relative merits as a blast-furnace fuel, giving the procedure and results of a test. 4800 w. Ir Age—June 11, 1903 No. 55723.

Retort Oven Coke for Foundry Use. W. J. Keep. Describes briefly the old fashioned bee-hive oven and the newer retort oven, and gives the writer's experience with retort oven coke. 1200 w. Jour Am Found Assn—June, 1903. No. 55750.

Coke Oven.

The Bauer Coke Oven. An illustrated description of an oven claiming a large yield of coke of good quality, and an economical utilization of the volatile constituents. 2500 w. Col Guard—June 12, 1903. No. 55869 A.

The Hennebutte System of Coke-Making. M. Warolus. Describes this system and reports its application at the Houssu Colliery. 900 w. Col Guard—May 29, 1903. No. 55679 A.

France.

Methods of Working Coal in the North of France. An account of methods, principally in inclined seams, as given in the report of the Prussian Royal Commission. Ill. 1200 w. Ir & Coal Trds Rev —May 22, 1903. No. 55548 A.

Haulage.

Compressed Air and Electricity for Haulage in Coal Mines. A commentary on W. B. Clarke's paper, read at meeting of the Am. Inst. of Min. Engrs. 2000 w. Mines and Min—June, 1903. No. 55572 C.

Peat.

See Mining and Metallurgy, Miscellany.

Pennsylvania.

Coal Production of Pennsylvania. Statistics from the reports for 1902, with remarks. 1000 w. Eng & Min Jour—June 6, 1903. No. 55715.

United States.

See Industrial Economy.

Washery.

The Bellevue Washery of the D. L. & W. R. R. Co., Scranton, Pa. George W. Harris. Illustrates and describes the methods and machinery employed in handling and separating coal from culm banks. 3500 w. Mines & Min—June, 1903. No. 55565 C.

COPPER.

Concentration.

A Point in Concentration. M. A. Knapp. Diagram, with explanation, of the effect of cutting out concentrates and middlings at seven different points, on a table which is handling low-grade copper ore carrying 3.1 per cent. of copper. 1700 w. Eng & Min Jour—June 20, 1903. No. 55996.

Cupro-Silicon.

Cupro-Silicon (Cuprosilicium [Siliciumkupfer]). Gustav Kroupa. An account of this combination of copper and silicon, which is now produced in the electric furnace, and of its uses. 1600 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 23, 1903. No. 56035 D.

Extraction.

A Proposed Process for Extracting Copper from Low Grade Ores. G. D. Van Arsdale. Notes on some reactions in which sulphur-dioxide is used as a precipitant of copper from sulphate solutions, and as a means of producing sulphuric acid for leaching. 1000 w. Eng & Min Jour—June 6, 1903. No. 55711.

New Mexico.

The Copper Deposits of the Sierra Oscura. H. W. Turner. An account of some low-grade mines in New Mexico. 1500 w. Pacific C Min—May 23, 1903. No. 55600.

Treatment.

Treatment of Low Grade Copper Ores. Dr. Edward Dyer Peters. Read before the Inst. of Min. Engrs., England. Enumerates and briefly considers the methods of treating these ores, with suggestions. 1300 w. Min Rept—June 4, 1903. Serial. 1st part. No. 55693.

GOLD AND SILVER.

Alaska.

The Gold-Bearing Gravels of Alaska. John D. McGillivray. A brief summary of their position and extent, with suggestion of means for vastly increasing their accessibility by a logical and inexpensive policy of taxation and road building. Illustrated. 3800 w. The Engineering Magazine—July, 1903. No. 56169 B.

Aurite.

Aurite, and a General Theory of Gold Ore Genesis. Joseph Voyle. Describes this new alloy, or exude, which the writer believes to be the universal primary origin of all gold. 1200 w. Min & Sci Pr—June 13, 1903. No. 56102.

Australia.

Review of the Progress of Gold Mining in Australia During 1902. Donald Clark. Reports concerning Western Australia, Victoria, Queensland, New Zealand, Tasmania, New South Wales and South Australia. 3000 w. Eng & Min Jour—June 6, 1903. No. 55709.

California.

Gold Quartz Mining in Kern County. C. S. Long. An illustrated article giving information of the industry near Kernville, Cal. 1200 w. Pacific C Min—May 23, 1903. No. 55602.

How Nevada County Shows in Mining. J. O. Denny. An outline of its past career as an important gold-producing district. Ill. 4000 w. Pacific Coast Min—May 30, 1903. No. 56120.

New Plant of the Royal Consolidated Mines Co., Ltd., Hodson, Cal. Horace F. Brown. Illustrates and describes recent improvements consisting of a modern 120-stamp, wet-crushing gold mill, a new crushing and hoisting plant at the mines, and an electric tramway from mine to mill. 1500 w. Min & Sci Pr—May 23, 1903. No. 55562.

Cyanide Slimes.

The Extraction of Gold from Cyanide House Slimes by a Wet Method. John Fleming. Sketches a process tried by the writer, describing two experiments made, and discussing results. Ill. 5000 w. Jour Chem & Met Soc of S Africa—April, 1903. No. 55666 E.

Deposits.

Observations on Gold Deposits. Chester Wells Purington. The first of a series of three articles on the occurrence of gold ores in distant regions. 2300 w. Eng & Min Jour—June 6, 1903. Serial. 1st part. No. 55712.

Dumps.

The Sampling of Mine and Mill Dumps. A. W. Warwick. Illustrates by an example the tendency to overvalue these dumps in the present article. 800 w. Min Rept—June 11, 1903. Serial. 1st part. No. 55812.

Georgia.

Dahlonega District, Georgia. Edwin C. Eckel. Reprinted from *Contributions to Economic Geology*. A description of the location, and the geology of the gold and pyrite deposits as shown in some of the mines now working. 3300 w. Mines & Min—June, 1903. No. 55568 C.

Lower California.

Santa Catarina District in Baja California. Morris McCarthy. An illustrated account of promising copper, silver, and gold mines in Lower California. 3500 w. Pacific C Min—May 23, 1903. No. 55601.

Queensland.

Mount Hector. C. F. V. Jackson. Preliminary report on a recent discovery of gold and copper ores in Queensland. 2800 w. Queens Gov Min Jour—April 15, 1903. No. 55623 B.

Recent Mining Developments on the Ravenswood Goldfield. Walter E. Cameron. A geological survey report giving information of this district. Map. 5500 w. Queens Gov Min Jour—April 15, 1903. No. 55624 B.

Sampling.

Notes on Automatic Ore Sampling. Alfred Harvey. Principally a description of the working of the Vezin Sampler. Diagrams. 1400 w. Min & Sci Pr—June 6, 1903. No. 55818.

An Automatic Sampler for Tailings, Sands and Slimes. C. H. Pead. Illustrated description of a design by the writer which has given good results. 700 w. Jour Chem & Met Soc of S Africa—April, 1903. No. 55667 E.

Sorting.

Ore Sorting. A. W. Warwick. Calculations showing an increase in profit when the ore is sorted. 1200 w. Min Rept—June 4, 1903. No. 55692.

Tasmania.

Smelting at Mt. Lyell, Tasmania. Abstracted from the report of the Secretary for Mines, Tasmania. Description, with illustration of works. 3200 w. Eng & Min Jour—May 30, 1903. No. 55579.

Yukon.

Methods and Values on the Yukon. John D. McGillivray. An account of the improvements in methods and reduction in cost of working, with general information. Warns capitalists to consider the cost of transport before investing in this region. 2200 w. Eng & Min Jour—June 13, 1903. No. 55843.

IRON AND STEEL.

American Iron.

American Iron Trade Outlook. Editorial discussion of the pig-iron situation in America, and commenting on editorials in the *N. Y. Times* and the *Iron Age*. 1600 w. Engng—June 12, 1903. No. 55-050 A.

Blast-Furnace Explosions.

Blast Furnace Explosions Due to the Hanging of the Charge (Ueber die Durch das Hängen der Gichten Veranlassten Hochofenexplosionen). Director Schilling. A paper before the Verein Deutscher Eisenhüttenleute on blast-furnace explosions and their causes, and upon the sticking of the charge, and the consequent abnormal reactions. Discussion. 3000 w. Stahl u Eisen—May 15, 1903. No. 56-177 D.

Casting Machinery.

Pig-Iron Casting and Conveying Machinery. E. A. Uehling. An illustrated article reviewing its development in the United States. 7500 w. Cassier's Mag—June, 1903. No. 55917 B.

Electric Furnaces.

Electric Furnace Methods of Iron and Steel Production. John B. C. Kershaw. Gives details of electric furnaces designed for the production of iron and steel which have had actual trial, with diagrams where possible. 1800 w. Elec Rev, N. Y.—June 6, 1903. Serial. 1st part. No. 55702.

Furnace Obstructions.

The Menne Process for Removing Obstructions in Blast Furnaces and Elsewhere (Mitteilungen über ein Verfahren zum Beseitigen von Hochofenansätzen und Dergleichen). Dr. Menne. A paper before the Verein Deutscher Eisenhüttenleute, describing a process for removing metallic and other solidified obstructions in blast and other furnaces by melting them with their own heat of oxidation. Discussion. 1500 w. Stahl u Eisen—May 15, 1903. No. 56178 D.

Pig Iron.

Loss of Sulphur in Borings of Pig or Cast Iron. W. E. Dickson. An account of the writer's experience showing that borings of pig or cast iron lose very appreciable amounts of sulphur on standing. 600 w. Jour Am Found Assn—June, 1903. No. 55745.

See also Industrial Economy.

Steel Manufacture.

Eliminating Gases and Slags from Molten Steel. F. C. Weber. Remarks on the methods that have been devised for this purpose, and the work of the writer in this field. 900 w. Ir Trd Rev—May 28, 1903. No. 55554.

Steel Works.

Britannia Steel Works, Middlesbrough. Gives an introductory description of the chief incidents in the formation of this firm, with a detailed account of the reconstructed works and the appliances with which they are equipped. Ill. 4000 w. Engng—June 12, 1903. Serial. 1st part. No. 55947 A.

The Works of the Lackawanna Steel Company. The present article gives a general illustrated description of the different parts of the plant at Buffalo, and their purposes. 5500 w. Eng Rec—May 30, 1903. Serial. 1st part. No. 55582.

Structural Steel.

See Civil Engineering, Materials.

Sweden.

Iron Mining in Sweden (Ueber den Schwedischen Eisenerzbergbau). Arpád Zsigmondy. An illustrated article from *Bány és Koh. lapok,* giving a description of the iron ores and mines of Sweden. Serial. 2 Parts. 3 Plates. 6000 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 23 and 30, 1903. No. 56034 each D.

United States.

See Industrial Economy.

Vancouver.

Iron Ore Deposits of Vancouver and Texada Islands. W. M. Brewer. Describes these deposits, giving theories relative to the origin of these ores, discussing matters relating to the production. 2500 w. B C Min Rec—June, 1903. No. 55-775 B.

MINING.

Ankylostomiasis.

The Extension of Ankylostomiasis in German Coal Mines. A statement of the gravity of this disease among the underground workers, and what is being done to combat it. 1500 w. Col Guard—June 5, 1903. No. 55790 A.

Excavating.

Mining and Other Excavating by Steam Shovels and Modern Electric and Steam Driven Dredges. Frank C. Perkins. An illustrated article describing systems now used, and giving examples of their application. 2500 w. Min Rept—June 11, 1903. No. 55813.

Exploration Work.

Test Drilling on the Mesabi Iron Range. Kirby Thomas. An illustrated account of the exploration work in progress. About 250 drills, of all classes, are employed. 2000 w. Eng & Min Jour—June 13, 1903. No. 55844.

Explosives.

A New Safety Explosive. Richard T. Dana. Gives tests made by the writer of an explosive, known as Joveite, having picric acid and sodium nitrate for the principal constituents, and reports its use, comparing it with other explosives. 3500 w. Pro Am Soc of Civ Engrs—May, 1903. No. 55769 E.

Testing Safety Explosives at Gelsenkirchen. Bergassessor Beyling, in *Glückauf*. Describes the method of testing and gives tabulated results. 800 w. Col Guard—May 22, 1903. No. 55537 A.

Freezing Process.

Sinking by the Freezing Method and Its Difficulties. Translated from *Glückauf*. Particulars given by R. Pierre of the difficulties met with in sinking by this process at the Laura and Vereeniging Colliery, in Holland. Ill. 4200 w. Ir & Coal Trds Rev—June 5, 1903. No. 55-804 A.

Head-Works.

Head-Works Framing. Charles H. Fitch. Outlines of framing used, discussing stresses. 1500 w. Min & Sci Pr—June 13, 1903. No. 56101.

Head-Works Framing—Primary Notions. Charles H. Fitch. Explanations of the stresses in tower frames. 1200 w. Min & Sci Pr—May 23, 1903. No. 55561.

Hydraulic Mining.

Hydraulic Mining in Southern Oregon. A. B. Cousin. A brief account of its history and possibilities. Ill. 2300 w. Pacific C Min—May 23, 1903. No. 55603.

Miner's Phthisis.

So-Called Anthracosis and Phthisis in Coal Miners. R. S. Trotter. From the *British Medical Jour.* Gives statements tending to show that coal dust is not the cause of these troubles, that phthisis is not common among miners, nor due to their occupation. 800 w. Ir & Coal Trds Rev—May 29, 1903. No. 55687 A.

Miner's Phthisis. Continued discussion of paper by William Cullen. 9500 w. Jour Chem & Met Soc of S Africa—April, 1903. No. 55668 E.

Mining Law.

The Rarus-Pennsylvania Case. R. W. Raymond. A reply to a criticism of an earlier article, discussing points in this recent decision. 1800 w. Eng & Min Jour—June 6, 1903. No. 55710.

Packing Mines.

The Hydraulic Packing of Coal Mines (Bergversatz mit Wasserspülung am Dreifaltigkeitsschachte). Karl Cizek. An address before the Mining and Metallurgical Society of Moravian Ostrawa, giving a description of the filling of the workings of the Trinity coal mine, in Polish Ostrawa, Austria, with material from the surface conveyed hydraulically, in order to get out the pillars left standing. 3000 w. Oesterr Zeitschr f Berg u Hüttenwesen (Supplement)—April 25, 1903, and also with plate, May 30, 1903. No. 56030 D.

Packing Goaf with Sand and Granulated Slag by the Flushing Process. C. Cizek, in *Oesterreichische Zeitschrift für Berg- und Hüttenwesen.* Describes this system, which has been successfully carried out, stating its advantages where applicable, and claiming a large recovery of coal. 700 w. Col Guard—June 12, 1903. No. 55871 A.

Quarrying.

Electricity in French Slate Quarries. Describes the former methods of working, and the recent method of working by electric power. Diagram. 2700 w. Engng—May 22, 1903. No. 55538 A.

Rockdrilling.

Compressed-Air vs. Electric Rock Drills (Die Gesteinsbohrmaschinenfrage im Jahre 1902. Druckluft und Elektricität). Q. Classen and Hugo Drolz. Discussion as to the relative advantages and costs of compressed-air and electric rock drills. 3500 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 18, 1903. No. 56-027 D.

Shaftsinking

Shaftsinking in the Ruhr Coal District, Germany (Schachtabteufen im Ruhrkohlenbezirk). An account of various methods of sinking shafts for coal mines and their cost, in Westphalia. 3000 w. Zeit schr d Oesterr Ing u Arch Vereines—June 5, 1903. No. 56023 B.

Southern States.

Southern Mining Impressions. An account of the development going on and improvements visible in the mining regions of the South. 4000 w. Mines & Min—June, 1903. No. 55569 C.

Speed Indicator.

See Mechanical Engineering, Miscellany.

Timbering.

Mining Methods and Safety Measures in the Wilczek Mines in Polish Ostrawa (Ueber einige Baumethoden auf den Gräflich Wilczekschen Gruben in Polnisch-Ostrau und über Sicherheitsmassnahmen bei Denselben). Josef Mauerhofer. Illustrated description of timbering and other mining methods and safety appliances in Austrian coal mines. Serial. 2 Parts. 1 Plate. 5000 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 16 and 23 1903. No. 56033 D.

Tin.

Method of Removing Overburden at the New Brothers Home No. 1 Tin Mine, Tasmania. James B. Lewis. Illustrated description of these deposits and the method of removing the overburden and the stripping of the drift. 2500 w. Eng & Min Jour—May 30, 1903. No. 55578.

Wells.

Breathing Wells. W. H. Booth. Illustrations showing the principles governing their action which are of special interest to miners. 1200 w. Mines & Min—June, 1903. No. 55570 C.

MISCELLANY.

Aluminum.

Production of Aluminum in 1902. Joseph Struthers. From Mineral Resources of the United States, Calendar year 1902. Information relating to production, prices, imports, etc. 1800 w. Ir Trd Rev—June 18, 1903. No. 55883.

Bosnia-Herzegovina.

Mining and Metallurgy in Bosnia and Herzegovina in 1902 (Das Berg- und Hüttenwesen in Bosnien und Herzegovina im Jahre 1902). Statistical tables. 1000 w. Oesterr Zeitschr f Berg u Hüttenwesen—June 6, 1903. No. 56038 D.

Frank Disaster.

The Frank Disaster. Several accounts, with illustrations, of the rock slide on Turtle Mountain, which buried this mining town on the C. P. Railroad, and caused great loss of life. A vertical seam of coal was being worked. 4500 w. Can Min Rev—May 30, 1903. No. 55563 B.

The Great Rock-Slide at Frank, Alberta. William Pearce. An illustrated account of the disaster on the morning of April 29th, which buried this town and killed 66 men, women, and children, blocking the Canadian Pacific Ry. track for about a mile and a half. Also report of the official investigation. 3300 w. Eng News—June 4, 1903. No. 55626.

The Rock-Slide at Frank. Reports, with interesting illustrations, of this catastrophe, describing the features of interest, and the present condition of the locality. 2000 w. Can Engr—June, 1903. No. 55696.

Great Britain.

The Mineral Wealth of Great Britain. Editorial review based on the record in a recent Home Office report. 1200 w. Engng—May 22, 1903. No. 55541 A.

Lead Smelting.

A Native Lead Smelting Furnace, Mexico. A. H. Bromly. Read before the Inst. of Min. Engrs., England. Illustrates and describes a primitive smelting plant. 900 w. Min Rept—May 28, 1903. No. 55551.

Molybdenite.

Molybdenite—Its Occurrence, Concentration and Uses. J. Walter Wells. Gives results of experimental work to determine the different methods of concentrating the ores. Also its occurrence in Canada is reported, and its industrial uses considered. Ill. 5800 w. Can Min Rev —May 30, 1903. No. 55564 B.

Oil Concentration.

An Automatic Process of Oil Concentration in Successful Use in Peru and Bolivia. J. W. Van Meter. An illustrated description of an ore-concentrating plant at Yauli, Peru. It has a capacity of 40 tons daily. 1500 w. Pacific Coast Min—May 30, 1903. No. 56119.

Oil Field.

Beaumont Oil Field. H. H. Stock. An illustrated account of the recent fire and the present condition of the field and the development in progress. 2000 w. Mines & Min—June, 1903. No. 55567 C.

Ore Deposits.

Peculiar Mines and Ore Deposits of the Rosita and Silver Cliff Mining District of Colorado. A. M. Welles and Prof. Arthur Lakes. Illustrated description of the ore deposits in a volcanic throat. 4000 w. Mines & Min—June, 1903. No. 55-566 C.

Peat.

The Peat Industry in Galicia (Torfverwertung in der Industrie). Jan Blauth Abstract of a report to an assembly in

Cracow, giving a review of the use of peat, particularly as a fuel, and of the development of the peat industry in Galicia. 2500 w Oesterr Wochenschr f d Oeff Baudienst—April 25, 1903. No. 56-003 D.

Salt.

The Salt Industry in Austria, in 1900 (Die Salinen Oesterreichs im Jahre 1900). Abstract from a government report, giving statistics of salt mines and salt works and their operation, employees, etc. Serial. 3 Parts. 6000 w. Oesterr Zeitschr f. Berg u Hüttenwesen—April 4, May 9 and 16, 1903. No. 56025 each D.

The Occurrences of Salt in Roumania (Das Salzvorkommen in Rumänien). W. Teisseyre and L. Mrazec. A geological and general description of the salt beds and salt mines of Roumania. Illustrations and map. Serial. 4 Parts. 1 Plate. 6000 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 11, 18, 25 and May 2, 1903. No. 56026 each D.

Rock Salt Mining in Kansas. W. R Crane. Describes the room- and pillar-system of mining employed. 2300 w. Eng & Min Jour—June 6, 1903. No. 55714.

Slate.

The Slate Quarries of East Liguria. An account of the slate quarries of Northern Italy and the improved methods of working made necessary by competition. 2000 w. Quarry—June, 1903. No. 55-726 A.

Tin.

The Malay Tin Deposits. R. A. F. Penrose, Jr. Abstract of an article in the *Journal of Geology*. Considers the geographical position and general geology of the tin regions, the location of the Kinta district, mode of occurrences, origin, and commercial features. Ill. 3000 w. Eng & Min Jour—June 20, 1903. No. 55993.

The Sain Alto Tin Deposits. J. Nelson Nevius. Information of the tin deposits in Mexico, with statistics of the Sain Alto bills of sale for the last three years. 700 w. Eng & Min Jour—June 30, 1903. No. 55994.

Zinc Furnace.

A Furnace for the Continuous Distillation of Zinc and the Direct Working of the Residues (Kontinuierlicher Schachtzinkdestillierofen mit Direkter Verarbeitung der Rückstände). Hr. Schmieder. An illustrated description of a furnace and process which works continuously, prevents loss of material and is economical of labor. 1500 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 25, 1903. No. 56029 D.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Railroad Police.

The Railroad Police. Josiah Flynt. Showing the value and economy of a systematic police organization. 4000 w. R R Gaz—June 12, 1903. No. 55837.

Rules.

The Standard Code on the C. N. O. & T. P. Gives extracts from the rules for conductors, with remarks. 4800 w. R R Gaz—June 19, 1903. No. 55979.

MOTIVE POWER AND EQUIPMENT.

Air Pumps.

Economical Repairs to 9 ½ Inch Air Pumps. Otto Best. An account of what the writer considers the best practice. 1200 w. Ry Age—June 12, 1903. No. 55815.

Boilers.

Maintenance of Boilers and Roundhouse Work. Reynold C. Young. Read at Columbus Convention of International Ry. Master Boilermakers' Assn. Considers the causes that increase the cost of maintenance, and the repairs and care in roundhouse work. 1400 w. Ry & Engng Rev—June 6, 1903. No. 55700.

Brakes.

The Mechanics of Air-Brake Systems. H. G. Manning. Historical account showing that the systems in use differ only in small mechanical details, and discussing the points in which they differ. Ill. 2500 w. Trans Am Soc of Mech Engrs—June, 1903. No. 55894 C.

Handling the New York Engineers' Brake Valve. Considers the proper method of handling this mechanism. 1500 w. Loc Engng—June, 1903. Serial. 1st part. No. 55614 C.

Car Frames.

Steel Frames for Cars. C. A. Seley. Gives a steel frame box car design, and discusses the use of steel in car construction. Ill. 1000 w. Am Engr & R R Jour—June, 1903. No. 55642 C.

Cars.

New Designs of 100,000-Lbs. Capacity Steel Gondola Car. E. W. Summers. Illustrated description. 700 w. Ry & Engng Rev—May 30, 1903. No. 55577.

Some Notes on Steel Car Repairing. Describes the arrangements and methods at some of the shops identified with the early history of these cars. 2400 w. R R Gaz—June 5, 1903. No. 55659.

Couplers.

A New Automatic Buffer Coupling. Charles Rous-Marten. An illustrated description of the Allison Smith automatic buffer coupler. Engr, Lond—May 22, 1903. No. 55546 A.

Roe's "Bull's Eye" Coupler and Central Buffer Draw Gear. An illustrated description of an automatic railway coupling now undergoing tests at the trials by the Russian railway officials. 500 w. Prac Engr—June 5, 1903. No. 55724 A.

Dynamometer Car.

The Orleans Dynamometer Car. Mr. Huet. An illustrated description, translated from the *Revue Générale des Chemins de Fer.* 2300 w. R R Gaz—June 19, 1903. No. 55982.

Dynamometer Tests.

Dynamometer Tests on the Canadian Pacific Railway. L. J. Houston, Jr. An illustrated article giving an account of tests made between Fort William and Winnipeg, with information concerning the traffic. Tables and plates. 3000 w. Trans Assn of Civ Engrs of Cornell Univ—1903. No. 55928 F.

Lignite Fuel.

Lignite Burning in Locomotives. M. H. Wickhorst. Gives results of experience with the burning of lignite coal in locomotives in Montana, with methods and results of smoke-box analyses. Ill. 1200 w. Am Engr & R R Jour—June, 1903. No. 55647 C.

Locomotive Operation.

Leaky Flues and Circulation in Wide Firebox Locomotives. John Player. Discusses the causes of trouble, the chief being the class of fuel used, the inexperience of firemen and engineers, and the ignorance of those in charge at terminals. 1500 w. Am Engr & R R Jour—June, 1903. No. 55646 C.

Locomotives.

British Locomotives for Abroad. Charles Rous-Marten. Discusses the locomotive industry of Great Britain, giving illustrations of British engines recently constructed for the export trade. 4000 w. Page's Mag—June, 1903. Serial. 1st part. No. 55911 B.

Compound Consolidation Locomotive for the Southern Pacific. Illustrated description of large recently built engines. The principal new feature is the semi-cylindrical tender for oil and water. 400 w. Ry Age—June 5, 1903. No. 55699.

Compound Passenger Locomotives, 4-4-2 Type. Diagrams and description of Vauclain four-cylinder balanced compound locomotives for the A., T. & Santa Fe Ry. 600 w. Am Engr & R R Jour—June, 1903. No. 55643 C.

Four-Cylinder Compound Goods Locomotive. Illustrated description of engine used for heavy express trains on the L. & N. W. Ry. 300 w. Engr, Lond—May 29, 1903. No. 55683 A.

Freight Locomotives of the Kansas City Southern Railway. Line drawings, photograph and general description of one of five recently built engines. 800 w. Ry Mas Mech—June, 1903. No. 55690.

French Express Engine for an English Railroad. Brief illustrated description of the type of new four-cylinder compound express engine building for the Great Western Ry., England. 600 w. Sci Am—June 20, 1903. No. 56106.

Heavy Eight-Wheel Passenger Engines for the Delaware & Hudson. Illustrated detailed description with general dimensions and remarks on this type of engine. 800 w. Ry Age—June 12, 1903. No. 55814.

Large Locomotives. A summary of opinions in regard to their service and the causes of failures, with editorial comment. 4000 w. Ry Age—May 29, 1903. No. 55574.

New Passenger Locomotives for the Chicago & Alton Ry. Illustrated description of heavy engines designed to make long runs with heavy trains at high speed. 1500 w. Eng News—May 28, 1903. No. 55589.

Pennsylvania R. R. Standard Passenger Locomotives. Describes an engine representing the highest type of construction thirty-five years ago, and also the most recent locomotives of the road named. These are of the 4-4-2 type wide firebox, Belpaire boiler, passenger locomotives for heavy and fast work. 2500 w. Ry & Engng Rev—June 20, 1903. No. 56100.

Steam Distribution of the Vauclain Compound Locomotive. Lawford H. Fry. Introductory description, showing how the theoretical diagram given, constructed by Zeuner's method, represents the processes through which the steam passes. 3000 w. R R Gaz—May 29, 1903. No. 55593.

Switching Locomotives, Pittsburg, Shawmut & Northern Railroad. Illustrates and describes a medium size engine intended for heavy switching service where there are sharp curves and heavy grades. 500 w. Ry Age—May 29, 1903. No. 55573.

Tendencies in Locomotive Design. A review of the development of the different types, showing the conditions that had to be met and the expedients used, and describing notable engines. 1 plate. 5500 w R R Gaz—June 19, 1903. No. 55980.

The Proportions of Modern Locomotives. Lawford H. Fry. Gives tabulated results of investigations of over 200 modern locomotives of all classes, with notes. 1500 w. Am Engr & R R Jour—June, 1903. No. 55645 C.

The Steaming Capacity of Locomotives. Editorial, reviewing briefly some of the methods proposed for comparing the steaming capacity of locomotives, and giving methods of making the calculations. 2700 w. R R Gaz—June, 1903. No. 55986.

Why Foreign Locomotives May Be More Efficient Than Ours. W. A. Buckbee. Thinks they have given more attention to smoke-box arrangement and heating service. 1200 w. Loc Engng—June, 1903. No. 55613 C.

Locomotive Tractive Power.

Chart for Tractive Power of Locomotives. Diagram, with description of its construction and use. 400 w. Am Engr & R R Jour—June, 1903. No. 55649 C.

Oil Burning.

Oil Burning Atlantic (4-4-2) Type Locomotive for the Southern Pacific. Illustration, with brief description. 150 w. R R Gaz—June 12, 1903. No. 55838.

Painting Locomotives.

Locomotive Painting. Extracts from a paper read at the April meeting of the Northwest Ry. Club, by C. J. Bishop. Gives formulae, and directions for securing protection and durability. 2500 w. R R Gaz—June 19, 1903. No. 55985.

Smoke Prevention.

Modern Equipment of Locomotives for the Prevention of Smoke—Using Coal or Oil as Fuel. W. M. Best. Considers the equipments of coal-burning and of oil-burning locomotives, favoring the latter. 3000 w. Pro Pacific Coast Ry Club—May 16, 1903. No. 55922.

Steam Car.

A Steam Railway Car. An illustrated description of a steam passenger car used on the London and South-Western Ry. for local traffic in the neighborhood of Portsmouth. 1700 w. Engng—May 22, 1903. No. 55539 A.

Suburban Cars.

Steel-Frame, Side-Door, Suburban Passenger Cars. Describes cars being built for the Illinois Central upon a new plan; the basis of construction is the use of side doors. 1800 w. Ill. Am Engr & R R Jour—June, 1903. No. 55641 C.

Superheating.

See Mechanical Engineering, Steam Engineering.

Tender.

Tender for Compound Locomotive; Mediterranean Railway, Italy. Two-page plate of sectional views, with illustration and details of tender, chief dimensions, weights, etc., of these recently constructed engines. 1000 w. Engng—June 5, 1903. No. 55793 A.

Train Resistance.

A Rational Train Resistance Formula. John Balch Blood. A brief history of train resistance formulae and their development, with discussion of each. 3000 w. Trans Am Soc of Mech Engrs—June, 1903. No. 55901.

NEW PROJECTS.

Switzerland.

The Railway from Reichenau to Ilanz, Switzerland (Die Neuen Linien der Rhätischen Bahn. Die Bahn Reichenau-Ilanz). P. Saluz. An illustrated description of the construction of a short railway up the Hitler Rhine valley in eastern Switzerland. Map and profile. Serial. 2 parts. 4500 w. Schweiz Bauzeitung—May 30, June 6, 1903. No. 56045 each D.

The Railway from Erlenbach to Zweisimmen, Switzerland (Die Lokalbahn Erlenbach-Zweisimmen). K. Becker. An illustrated description of a railway in the Simmenthal, forming a link of a direct line between Lakes Thun and Geneva, and its construction. Map and profile. 2500 w. Schweiz Bauzeitung—May 2, 1903. No. 56042 D.

Tropics.

Railway Building in the Tropics. John L. Caspar. An illustrated article on the construction of the Northern Railway of Guatemala, and the Honduras Railway. 2800 w. Gunton's Mag—June, 1903. No. 55744.

Utah.

Line Changes on the Rio Grande Western Ry., in Utah. W. P. Hardesty. Briefly outlines the history of the road, and describes the improvements made and proposed. Ill. 2200 w. Eng News—June 4, 1903. No. 55628.

PERMANENT WAY AND FIXTURES.

Gates.

Improvements in Gates at Crossings (Neuerungen an Wegeschranken). Hr. Scholkmann. A paper before the Verein für Eisenbahnkunde, giving an account of improvements in hand-operated gates for railway grade crossings, and an illustrated description of an automatic gate worked by gas engine. 2000 w. Glasers Annalen—June 1, 1903. No. 56084 D.

Rail Re-Rolling.

See Mechanical Engineering, Machine Works and Foundries.

Roundhouse.

New Roundhouse of the Baltimore and Ohio Railway. Illustrated detailed description of a building to be erected at Holloway, Ohio. 1200 w. Ry Mas Mech—June, 1903. No. 55691.

Shops.

Proposed Extension of Lehigh Valley Railroad Shops at Sayre, Pa. Outlines the proposed plan for the gradual extension and rearrangement of the plant. 1000 w. Eng Rec—May 30, 1903. No. 55583.

The Great Northern Shope at St. Paul. Full illustrated detailed description of these shops. 2-page plate. 4000 w. R R Gaz—June 19, 1903. No. 55978.

Signalling.

Automatic Railway Signalling. Illustrates and describes the London & South-Western railway company's installation at Salisbury. 2000 w. Transport—May 29, 1903. No. 55661 A.

Col. Yorke on Automatic Signalling. The reply of H. A. Yorke in explanation of points misunderstood, and in reply to criticisms of his views as expressed in his recent report. 1800 w. Ry Age—June 19, 1903. No. 55999.

Electric Locking for Levers of Interlocking Machines. How best to use electric locking and the advantages. Ill. 2200 w. Ry Age—June 12, 1903. No. 55816.

Gillmor's Automatic Switch Lock. An illustrated description of the construction and operation. 1200 w. R R Gaz—June 12, 1903. No. 55839.

The Hall Electro Gas Signal. An illustrated description of the apparatus for working the Hall Semaphore signals by gas motors. 1700 w. R R Gaz—June 5, 1903. No. 55658.

The Marin Signal System for Railways (Das System Marin zur Sicherung Fahrender Eisenbahnzüge). Hr. Raffalovich. A paper before the Verein für Eisenbahnkunde, giving an illustrated description of a signaling system which automatically causes the locomotive whistle to blow, besides showing a visual signal. 2500 w. Glasers Annalen—June 1, 1903. No. 56085 D.

Electric Automatic Blocksignals on the Bannstein-Muttershausen Local Railway in Lorraine (Elektrisch Selbsttätige Blocksignale der Industrialbahn "Bannstein-Muttershausen" in Lothringen). L. Kohlfürst. A description, with diagram, of an electric signal system, designed by Georg Schreiber, on a short single-track branch railway, connecting an industrial works with a main line. 3000 w. Zeitschr f Elektrotechnik—April 26, 1903. No. 56047 D.

Clayton's Fog-Signalling Apparatus. An illustrated description of a mechanical apparatus for use on railways. 1100 w. Engng—June 5, 1903. No. 55792 A.

TRAFFIC.

Car Service.

Demurrage. A. W. Sullivan. Extracts from an address on "Car Service in Its Relation to Operation," delivered before the Nat. Assn. of Car Service Mgrs., at Chicago. 1300 w. R R Gaz—June 19, 1903. No. 55987.

MISCELLANY.

Expenses and Rates.

The Relations Between Operating Expenses and Rates (Die Beziehungen Zwischen Betriebkosten und Tarifen). E. Fränkel. A paper before the Verein für Eisenbahnkunde, giving a discussion of the proper distribution of operating expenses of railways, and their relations to rates. 3000 w. Glasers Annalen—June 1, 1903. No. 56083 D.

India.

Indian Railways. Reviews the report of Mr. Thos. Robertson, appointed as a special commissioner to inquire into the working of the system. 1600 w. Engr, Lond—June 12, 1903. No. 55943 A.

Queensland.

Queensland Railways and Colonial Development. Editorial discussion of the working of the State Railways, and the conditions they must meet. 1800 w. Engng—June 5, 1903. No. 55795 A.

St. Louis.

Affairs of the Terminal Railroad Association of St. Louis. A statement aiming to explain the relations of this association to the merchants and manufacturers. 3000 w. Ry & Engng Rev—May 30, 1903. No. 55576.

STREET AND ELECTRIC RAILWAYS

Accidents.

The Accident Record and Resultant Disbursements of the Milwaukee Electric Railway and Light Company. Quotes decisions of the highest court of Wisconsin, gives tabulated classification of accidents by months, and the amounts paid in connection therewith, and other financial statistics. 2000 w. St Ry Jour—June 20, 1903. No. 56104 D.

Accumulator Traction.

The Use of Accumulators for Traction

Purposes (Die Verwendung von Akkumulatoren zum Fahrbetrieb). W. v. Winkler. A general discussion of traction by means of storage batteries, of the batteries themselves, and of the conditions for success. Diagrams. Serial. 2 parts. 4500 w. Zeitschr f Elektrotechnik—May 31, June 7, 1903. No. 56053 each D.

Berlin--Lichterfelde.

Electric Traction on the Suburban Railway from Berlin to Gross-Lichterfelde-Ost (Die Elektrische Zugförderung der Vorortbahn Berlin - Gross - Lichterfelde - Ost). Kurt Meyer. Well illustrated description of the electrical equipment of a third-rail, direct-current road, about 6 miles long. Serial. Part 1. 4000 w. Zeitschr d Ver Deutscher Ing—June 6, 1903. No. 56078 D.

Electric Traction on Main Railways and the Electric Equipment of the Berlin-Gross Lichterfelde Ost Suburban Railway (Die Bisherigen Ergebnisse des Elektrischen Betriebes auf Hauptbahnen und die Einrichtung der Gegenwärtig in Ausführung Begriffenen Elektrischen Zugförderungsanlage für die Vorortstrecke Berlin-Gr. Lichterfelde Ost). Hr. Bork. Paper before the Verein für Eisenbahnkunde, giving a discussion of electric traction on main lines, and a well illustrated description of the electric equipment and rolling stock of a third-rail direct-current railway out of Berlin. 1 plate. 9000 w. Glasers Ann—May 15, 1903. No. 56082 D.

Canal Haulage.

A New System for Electric Haulage on Canals (Ueber ein Neues System für Elektrischen Schiffszug auf Kanälen). Julius Szász. An illustrated description of the system proposed by Ganz & Co. for the Teltow Canal, near Berlin, in which there is a locomotive with inclined axles and four wheels which run on a single rail. Three-phase current is used. Serial. 2 parts. 4500 w. Zeitschr f Elektrotechnik—May 3 and 10, 1903. No. 56049 each D.

Electric Haulage on Canals. Frank C. Perkins. Considers some of the work in this field, and the results of competition for haulage on the Teltow Canal. 3500 w. Elec Rev, N Y—June 6, 1903. No. 55703.

Electric Haulage on Canals. Frank C. Perkins. Considers work done in electric canal haulage, and gives an illustrated detailed account of the tests of systems made on the Teltow Canal, in Germany. 2000 w. Sci Am—June 27, 1903. No. 56147.

Chicago Terminal.

Fifty-second Avenue Terminal in Chicago. Brief illustrated description of an elaborate terminal station for the transfer of passengers, and storage of cars. 700 w. St Ry Jour—June 6, 1903. No. 55706 D.

Conduit System.

The London County Council Tramways—A Defence of the Conduit System. Considers the various objections made to the system. 1600 w. Elec Engr, Lond—May 22, 1903. No. 55535 A.

Freight Car.

Construction and Operation of a Freight-Car Driven by Induction Motors. A. B. Weeks. Describes the method of supporting trolley wires, the supply circuit, controllers, etc., for operating a flat car in a factory. 2000 w. St Ry Jour—June 6, 1903. No. 55708 D.

Interurban.

A Remarkable Iowa Interurban. Illustrated description of the Colfax branch of the system of the Interurban Ry. Co. of Des Moines, Iowa, which is of interest because of the remarkable amount of traffic in a sparsely populated territory. 2400 w. St Ry Jour—June 20, 1903. No. 56103 D.

Electric Interurban for Freight and Passengers. An illustrated detailed account of the recently opened section between Scranton and Pittston, of the Lackawanna & Wyoming Valley Railway. 7500 w. St Ry Jour—June 13, 1903. No. 55822 D.

Rockford & Interurban Railway Co. An illustrated article dealing with the growth and development of this Illinois system, the railways included in the new consolidated company, the organization, operating features, etc. 5500 w. St Ry Jour—June 20, 1903. Serial. 1st part. No. 55997 C.

The Lackawanna and Wyoming Valley Railroad. A brief general description, with illustrations, of a 35-mile, double-track, third rail line built and equipped for carrying freight and passengers. 3800 w. Eng Rec—June 13, 1903. No. 55846.

London.

The Electrification of the Underground. Wilfred Yorke. An illustrated description of the section from North Ealing to South Harrow. 2000 w.. Elec Rev, Lond—June 5, 1903. No. 55783 A.

Mersey, Eng.

Electric Traction on the Mersey Railway (Traction Electrique dans le Tunnel de la Mersey). Ch. Dantin. A well illustrated description of the electric railway under the Mersey, between Liverpool and Birkenhead, and its equipment. 6000 w. Génie Civil—May 16, 1903. No. 56150 D.

The Electrification of the Mersey Railway. An illustrated description of the replacing of steam power by electricity on an English suburban railway. 4800 w. Feilden's Mag—June, 1903. No. 55914 B.

Montreal.

Recent Additions to the Generating Plant of the Montreal Street Railway. Ralph D. Mershon. Illustrates and describes the addition of machinery and switchboard apparatus required for receiving power transmitted from hydraulic generating plant 17 miles distant. 900 w. St Ry Jour—June 6, 1903. No. 55707 D.

New York.

The Transportation Problem of Greater New York. W. W. Wheatley. A review of the present conditions, an outline of the transportation problem, with a sketch of the plans already formed for its solution, indicating the effect upon the metropolitan population. General discussion. 17000 w. N Y R R Club—May 15, 1903. No. 55923.

Section 4, New York Rapid Transit R. R. An illustrated description of the work from 34th to 41st St. It has two separate double-track, concrete-lined, rock tunnels, driven below the existing double-track street car tunnel. 2200 w. Eng Rec—June 6, 1903. Serial. 1st part. No. 55716.

North-Eastern Ry.

Electrical Traction on the North-Eastern Railway. An account of the proposed equipment for suburban traffic in the neighborhood of Newcastle-upon-Tyne. Ill. 2000 w. Elect'n, Lond—May 29, 1903. No. 55673 A.

Staten Island.

The Proposed Terminal at St. George, Staten Island. A statement of the recent propositions made by the steam and the electric transportation companies to furnish ferry service, with an illustrated description of the accepted plans. 1000 w. St Ry Jour—May 30, 1903. No. 55557 D.

Surface Contact.

Surface Contact Systems for Electric Street Railways (Knopfkontactsysteme für Elektrische Strassenbahnen). Josef Löwy. A paper giving an illustrated description of many of the surface-contact systems, and particularly of the electromagnetic system of Dr. Hillischer, of Vienna. Also, discussion. Serial. 2 parts. 4500 w. Zeitschr f Elektrotechnik—May 17 and 31, 1903. No. 56051 each D.

General Electric Company's Surface-Contact System. Illustrated description of this system, which consists of two rows of metal contacts, bedded in the pavement, and brought into connection with the car through the agency of light steel skates. The contacts of one row is energized by the car, those of the other supply power to the car. 4500 w. Engng—May 29, 1903. No. 55686 A.

The Magnetic Surface-Contact System. G. Paul. Points out some of the failings of this system and makes a comparison of the Diatto and the Lorain systems. Ill. 2300 w. Elec Engr, Lond—May 29, 1903. No. 55676 A.

Third-Rail.

The First Third-Rail Electric Railway in Italy. Enrico Bignami. An illustrated description of the Varese Railway system and its equipment. 4000 w. Elec Rev, N Y—May 30, 1903. No. 55595.

Trolley Trips.

From New York to Boston by Trolley. Gives four maps showing the electric railways in operation, proposed, and under construction, and the steam railroads. The trip can be made by electric railways with the exception of about 4 miles. Time, 20 hours and 5 minutes. Fare, $2.85. 300 w. St Ry Jour—June 20, 1903. No. 56105 D.

Short Vacations by Trolley. Albert Bigelow Paine. An illustrated article on the pleasures of trolley travel, describing principally the route between New York and Boston. 2500 w. World's Work—July, 1903. No. 56123 C.

Trucks.

Trucks for High Speed Electric Railroads. An interesting reiew of the development, with illustrations of many types for high speed service. 4000 w. R R Gaz—June 19, 1903. No. 55983.

Valtellina.

The Three-Phase Railway at Valtellina. An illustrated description of the electrical equipment and novel features of this Italian line, and its operation. 3500 w. St Ry Jour—May 30, 1903. No. 55556 D.

The Valtellina Electric Railway. Emile Guarini. An interesting account of the working of this line in Italy, and of the difficulties and trials, with related matter. 2700 w. Ry Age—May 29, 1903. No. 55575.

Vesuvius.

The Vesuvius Railway (Die Vesuvbahn). E. Strub. A well illustrated description of a combined adhesion, rack and cable railway up Mount Vesuvius, Italy, operated by electric current which is generated in a station with gas-engines and direct-current generators. Serial. 4 parts. 12000 w. Schweiz Bauzeitung—April 18, 25, May 9, 16, 1903. No. 56041 each D.

Wheels.

The Shape of Wheels on Electric Railways (Neigungswinkel des Laufradprofiles bei Elektrischen Bahnen). K. Sieber. A discussion of the influence of the degree of coning of wheels on the vibrations of cars and the wear of wheels and rails, and the best shape for wheels. 2500 w. Zeitschr d Ver Deutschr Ing—June 6, 1903. No. 56081 D

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.

Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* Philadelphia.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Feilden's Magazine. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Straussenbahnen. *s-m.* Berlin.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Pacific Coast Miner. *w.* San Francisco.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* Chicago.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Electrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

Electric Mining.

Electricity as Applied to Mining. By Arnold Lupton, G. D. Aspinall Parr and Herbert Perkin. Size, 9 by 6 in.; pp. vii, 280; figures, 171. Price, 10s. 6d. ($3.50). New York: D. Van Nostrand Company. London: Crosby Lockwood & Son.

As is remarked in the preface of this book, the use of electricity in mining twenty-five years ago was confined to signalling and shot-firing; twenty years ago only the beginnings of electric lighting had been made, and the applications of electric power came still later. But in recent years the use of electricity in various forms in and about mines has become so extensive that the collection of a great deal of valuable information, widely scattered through periodicals and the transactions of engineering societies, into a single volume is most timely and convenient. In the present work, after a general introduction on electricity and electrical apparatus, there are sections on electric generators and their driving; different prime movers, including the steam turbine; the distribution of electric energy; electric motors; electric cables; electric pumping and hauling; electric coal cutting; electric lighting; electric drilling; electric welding; and miscellaneous applications of electricity. There is also a discussion of electricity as compared with other methods of transmitting power; and the dangers of electricity and the methods of obviating them are considered.

Financial Electric Management.

The Finances of Gas and Electric Light and Power Enterprises. Second Edition. By William D. Marks, Ph. B., C. E. Size, 7 by 5 in.; pp. iii, 125; plates, 2. Price, $1. Philadelphia: Wm. D. Marks.

The commercial management of an electrical enterprise is at least as important to the owners and to the public as is its engineering design, but successful commercial management must be based on an appreciation of the various technical questions involved. The present book has been written from the standpoint of a man who has had experience as a manager of a large electric station, and who is therefore well able to view the electric supply business in both its financial and its engineering aspects. He gives a commercial analysis of small and unprofitable electric lighting, traction and power enterprises, and shows how they can be put upon a paying basis. Large central-station systems are also considered, and there is an extended discussion of methods of establishing fair prices for electric service, in which the subject of electric meters is reviewed. There are tables giving data of the electric light companies in Massachusetts, and the 1901 report of the gas commissioners of that State is analyzed and discussed, and deductions as to the proper price for gas drawn from it. There is a consideration of the subject of district steam and hot-water heating from electric central stations, and the conclusion arrived at that when properly designed such a system will pay. Although some of the author's opinions are open to controversy, this little book, as a whole, will prove very suggestive to the central station manager, and will give some valuable points to the intending investor in electrical enterprises.

River Improvement.

The Improvement of Rivers. A Treatise on the Methods Employed for Improving Streams for Open Navigation, and for Navigation by Means of Locks and Dams. By B. F. Thomas and D. A. Watt. Size, 12 by 9½ in.; pp. xiv, 356. Figures in the text, and 92 full-page and folding plates. Price, $6; postage, 47 cents additional. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The improvement of internal waterways is attracting more and more attention, both in this country and abroad, and that branch of hydraulic engineering relating to the regulation and canalization of rivers, in particular, has made great progress within recent years. But in spite of the importance of the latter subject, there has hitherto been no systematic treatment of it in the English language, its principal literature being of Continental origin, with British and American monographs, reports and papers on special features of it. The object of the present comprehensive work is to provide in concise form a description of the various systems employed for bettering the condition of navigable streams, together with the methods usually adopted for their design and execution. It has been endeavored to include all the important points of design and construction which are liable to be met with, and all calculations have been so simplified as to bring them within the range of those who have not received a thorough technical education, while at the same time this clear and plain treatment does not lessen the great value of the book to trained engineers. The first part of the volume relates to the preliminaries to river improvement and to surveying. The second part treats more particularly of the improvement of open rivers, and has chapters devoted, respectively, to the removal of bars and other obstructions; regularization; dikes and their effects; protection of banks; levees; storage reservoirs; and the improvement of river outlets. The third part, on the improvement of rivers by canalization, is the principal one, and here the authors speak with peculiar authority, for they have been actively engaged in the United States Government work of improving and canalizing the Ohio River and its tributaries. When these improvements are completed, there will here be the largest system of movable dams in the world, and the treatment of these engineering structures is therefore particularly full, the descriptions and illustrations of the latest and most modern types being of great excellence. The book is well and attractively made in every respect, and this, combined with its high intrinsic merit, will commend it most heartily to hydrographic engineers in particular and to the engineering profession in general.

Hydraulics.

Treatise on Hydraulics. By Mansfield Merriman. Eighth Edition. Size, 9¼ by 6 in.; pp. viii, 585; figures, 199. Price, $5. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Prof. Merriman's standard treatise on hydraulics, of which this is the eighth edition, is too well known to require any extended description, and too favorably known to need any praise. It will suffice to call attention to some of the changes that have been made since the last edition was issued. Two new chapters have been added, one on Hydraulic Instruments and Observations, which treats of the methods of measuring pressures and velocities, and another on Pumps and Pumping, in which the various machines for raising water are discussed from a hydraulic point of view. Among the new topics introduced in the other chapters may be noted the vortex whirl that occurs in emptying a vessel, new coefficients for dams and for steel and wood pipes, the loss of head in pipes due to curvature, branched circuits or diversions in pipe systems, the influence of piers in producing backwater, canals for water-power plants, discharge curves for rivers, the tidal and the land bore, water-supply estimates, water hammer in pipes, the stability of a ship, and hydraulic-electric analogies. Many new examples and problems are given and in these the author has endeavored not only to exemplify the theory of the subject, but also to illustrate the conditions of actual practice. Historical notes and references to hydraulic literature are presented with greater fullness than before. The hydraulic tables have been gathered together at the end of the volume, instead of being scattered throughout the text, and the most important tables are presented both in the English and in the metric system, the latter not being a mere transformation of the former, but being arranged to be used with metric arguments. The principal metric data, coefficients, formulas, and problems are also given at the end of each chapter. While the main purpose in rewriting the book has been to keep it abreast with modern progress, a successful attempt has also been made to present the subject more concisely and clearly than before, in order to advance the interests of thorough education and to promote sound engineering practice.

BOOKS ANNOUNCED.

Ventilation in Mines. By Robert Wabner. Translated from the German by Charles Salter. Price, 10s. 6d. ($4.50). London: Scott, Greenwood & Co., New York: D. Van Nostrand Company.

The American Steel Worker. By E. R. Markham. Price, $2.50. New York: The Derry-Collard Company.

Die Herstellung der Akkumulatoren. By F. Grünwald. Price, 3 marks ($1). Halle a. S., Germany: Wilhelm Knapp.

Photographic Lenses. A Simple Treatise. Second Edition. By Conrad Beck and Herbert Andrews. Price, 75 cents. London: R. & J. Beck, Ltd., and Percy Lund, Humphries & Co., Ltd. New York: Tennant & Ward.

Experiments on the Flexure of Beams. By Albert E. Guy. Price, $1.25. New York: D. Van Nostrand Company. London: Crosby Lockwood & Son.

Specifications for Material and Workmanship for Steel Structures. Adopted at the 1903 Convention of the American Railway Engineering and Maintenance of Way Association. Price, single copies, 10 cents; for ten or more copies on one order, 5 cents each. Chicago: E. H. Fritch, Secretary pro tem., 1562 Monadnock Block.

THE ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

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THE METALLOGRAPHY OF IRON AND STEEL.

By Henry M. Howe.

By special arrangement with Professor Howe, made at about the time he first entered upon the work of writing his great treatise on alloys which is shortly to appear in book form, and with the co-operation of his publishers, Messrs. Sauveur & Whiting, THE ENGINEERING MAGAZINE presents these papers selected and condensed from the forthcoming volume "Iron, Steel and Other Alloys."

The portions thus taken for advance publication are those which lend themselves most readily to magazine use for an audience vitally interested in the accurate knowledge of materials of construction, and in the elements of the science which gives that knowledge. In this field there have been few more important contributions than the following beautifully clear and explicit definition of the long-debated question "What is Steel?"

For anything more than the outline permitted by the necessary limitations of magazine publication, the student must be referred to the book. Of Professor Howe's foremost authority on the subject it is needless to say a word. It is internationally recognized. It is proper to say that on account of his present absence in travel the final proofs of the article which appears below have not had the advantage of his personal revision.—THE EDITORS.

WHAT are the iron and steel of commerce and industry? Examined under the microscope they prove to be composite or granitic substances, intimate mechanical mixtures or conglomerates of microscopic particles of certain quite distinct, well defined, simple substances, in widely varying proportions. The structure of these conglomerates is of the type shown on page 648, last month. The chief of these substances are,

1.—Pure (or nearly pure) metallic iron called *ferrite,* soft, weak, very ductile, with high electric conductivity, and in general like copper in its qualities, color excepted,

2.—A definite iron carbide, Fe_3C, called *cementite,* which is harder than glass and nearly as brittle, but probably very strong under gradually and axially applied stress.

Take immediately as the most important fact, the most essential part of the skeleton about which the various phenomena are to be grouped, that the great classes of iron and steel of chief value to the engineer and probably to the world at large, are essentially intimate mixtures or conglomerates of these two strikingly different microscopic constituents—ferrite extremely soft and ductile, cementite extremely hard and brittle, the former like copper, the latter like glass. The properties of several of the classes may indeed be influenced, and very profoundly, by thermal and mechanical treatment, and by the presence in certain of them of slag or of graphite; but the fact on which our attention should be concentrated at first is this, that the difference in properties between the different industrial classes of iron and steel is due chiefly to difference in the ratio which the ferrite bears to the cementite.

What has just been said does not apply, it is true, to what is called "hardened steel," which consists not of ferrite and cementite but essentially of austenite, as will be explained shortly; but it does apply to the great industrial classes of wrought iron and of steel such as ship, rivet, fencing-wire, tube, rail and tinplate steel, and indeed all structural steels whether for plates, beams, eye bars, angle irons or any like object.

The steels which are especially soft and ductile, e. g., the rivet and boiler-plate steels, consist chiefly of the soft, ductile, copper-like ferrite, as do those with very high electric conductivity, such as telegraph and telephone wires. In these steels the proportion of cementite may not exceed one per cent of the whole, the rest consisting almost wholly of ferrite.

The harder steels like rail steels, which are called upon to resist abrasion, e. g., the grinding action of the car wheels intensified by the presence of sand between wheel and rail, have a much larger proportion of cementite. About 93 per cent. of their total mass is made up of ferrite and the remaining 7 per cent consists of cementite. This quantity of cementite suffices to increase greatly the resistance to abrasion, while the loss of ductility which it causes, though very marked, is not dangerously great.

Naturally, as the proportion of cementite in steel increases and that of ferrite decreases, the ductility diminishes continuously and the hardness increases continuously; the tensile strength, however, reaches a maximum when the cementite amounts to about 15 per cent of the whole, and the ferrite is about 85 per cent; with further increase of cementite the tensile strength again decreases. These facts are sketched roughly in Figure 1. The lines in this figure are intended only to give a sort of bird's-eye view of the subject, because, for given constitution, the properties vary very greatly with the treatment which the metal has undergone. Indeed, in case of hardness trustworthy quantitative data are not at hand.

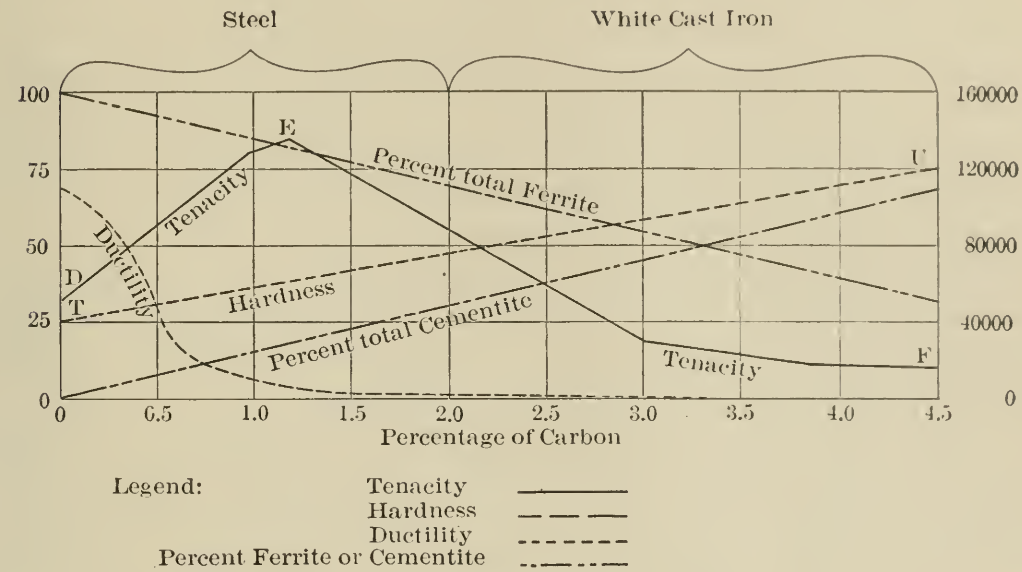


FIG. 1. PHYSICAL PROPERTIES AND ASSUMED MICROSCOPIC CONSTITUTION OF THE PEARLITE SERIES, GRAPHITELESS STEEL SLOWLY COOLED, AND WHITE CAST IRON.

By "Total Ferrite" is meant both that which forms part of the pearlite and that which is in excess of the pearlite, taken jointly. So with the "Total Cementite."

The constitution of steel is not in general reported in the percentages of ferrite and cementite; nor, indeed, are most engineers and metallurgists of today sufficiently familiar with this aspect of the subject to speak of it with confidence. But this is the aspect which the practitioners of the near future must face, and it is also that which enables us to understand the relation between the composition and properties of these different classes of iron and steel. Instead of saying that a certain kind of steel, for instance rail steel, contains so much cementite and so much ferrite, it is customary to report simply the carbon which that cementite represents. For instance, instead of saying that rail steel contains about 7.5 per cent of cementite and nearly 92.5 of ferrite, we habitually and for convenience say that it contains about 0.50 per cent of carbon, which is the quantity represented by the presence of 7.50 per cent of cementite.

Besides these two constituents of prime importance, ferrite and cementite, there are three others of moment; these are graphite, slag, and austenite.

Graphite: Gray Cast Iron.—Graphite is an important constituent of cast iron, especially of gray cast iron, but for our present purpose we may regard it as either absent from steel or, if present, only in unimportant quantities.

Gray cast iron, the only kind of cast iron which can be widely used by engineers, may be regarded as a conglomerate of the second degree; for it consists first of a mechanical mixture of ferrite with cementite quite as steel does; while through this mixture as a matrix there is scattered much free carbon in the form of sheets of graphite as shown on page 809. A weak, foreign body like graphite of course both weakens and embrittles the mass taken as a whole; hence the weakness and brittleness even of gray cast iron.

The graphite itself is pure or very nearly pure carbon in very thin, flexible sheets, which form a more or less continuous skeleton running through the mass of gray cast iron. It appears to be identical with the native mineral graphite (black lead, plumbago).

White cast iron typically would consist of cementite and ferrite quite as structural steel does, but with a much larger proportion of cementite, rising even to 67 per cent (say 4.50 per cent of carbon). Hence the extreme hardness and brittleness of this class of cast iron, so extreme as to exclude it from most engineering uses. But most of the white cast iron of commerce has a constitution intermediate between this extreme type on one hand and gray cast iron on the other; it contains much more cementite than gray cast iron and much less graphite. It is then, like gray cast iron, a conglomerate of the second degree, consisting first of a metallic matrix which is itself a conglomerate of much cementite with a variable proportion of ferrite, and second of a small quantity of graphite interspersed through this matrix.

Slag: Wrought Iron.—Wrought iron consists essentially of a metallic matrix identical with low-carbon steel, in which is mechanically mixed a small quantity of slag, a silicate of iron; this slag is not unimportant, yet it is far less important than the ferrite and cemenite of the matrix.

Austenite: Hardened Steel.—Steel hardened by sudden cooling from a red heat consists essentially of austenite, a solid solution of carbon in iron of varying degrees of concentration. When austenite contains as much as one per cent of carbon it is intensely hard and brittle; and indeed its hardness and brittleness are roughly proportional to the quantity of carbon which it contains. Hence steels for purposes which require extreme hardness, such as files and other tools for cutting metals and even wood, have from about 0.75 to 2.00 per cent of carbon, enough to give the degrees of hardness required for the special purpose, but not enough to cause a prohibitory degree of brittleness; and they are "hardened" by sudden cooling.

Besides the cutting tools, armor plate and projectiles are habitually made of hardened steel, and therefore consist essentially of austenite. Thus the austenitiferous steels are of importance, at least when contrasted with the non-ferrous metals; but the quantity of austenitiferous steel in actual use is but an insignificant fraction of the non-austenitiferous, that which consists essentially of ferrite and cementite.

Heat Treatment.—As has been mentioned in passing, the properties of certain classes of iron and steel are influenced very greatly by thermal treatment. While this appears to act (1) in part by changing the size and arrangement of the microscopic crystalline grains of which the conglomerate mass consists, and probably (2) in part by inducing allotropic changes in the iron proper, yet (3) a very large part of its influence is through shifting the condition of the carbon between the three states of cementite or iron carbide (Fe_3C), austenite or solid solution of carbon in iron, and free carbon or graphite. In view of this latter mode in which heat treatment affects the properties of the metal, it is but natural that its influence should in general be the more pronounced the more carbon the metal contains. Thus wrought iron and the very low-carbon steels containing from 0.06 to 0.10 per cent of carbon are in general but little affected by heat treatment; while the high-carbon steels are influenced most strikingly. Cast iron, too, may be affected very greatly by heat treatment.

Alloy steels, such as nickel, manganese, tungsten, chrome and molybdenum steel, have important specific qualities which collectively are of importance; but their importance is secondary to that of the great classes which have already been outlined.

To recapitulate, the essential distinction between wrought iron and steel is that the former necessarily contains a small quantity of slag, which the latter lacks. The great and striking distinction between steel and cast iron is that the former contains less carbon than the latter; the boundary between them may be put roughly at two per cent of carbon.

Division into Three Great Classes According to Carbon-Content.—Thus divided there are three great classes, which are as follows:

1.—With less than 0.30 per cent of carbon, called *soft* or *low-carbon steel* when free from slag, and *wrought iron* when containing slag; soft, ductile and relatively weak (tensile strength say 50,000 to 80,000 pounds per square inch in case of steel), i. e., weaker than the second class, higher carbon steels, yet far stronger than cast irons, and with relatively little hardening power.

2.—With between 0.30 per cent and 2.00 per cent of carbon, called *medium* and *high-carbon,* or *half-hard* and *hard steels,* harder, less ductile, and stronger than the low-carbon steels, more ductile and far stronger than the cast irons, and with marked hardening power. The tensile strength generally lies between say 80,000 and 130,000 pounds per square inch. The hardness and hardening power increase, and the ductility diminishes, as the carbon increases, in each case apparently without limit; while the tensile strength increases with the carbon content till this reaches about 1.00 or 1.20 per cent, and then again decreases,

3.—With more than 2.00 per cent of carbon, called *cast iron,* which is much weaker and much less ductile than classes 1 and 2. Cast iron may be either "white," "gray" or "mottled."

In white cast iron most of the carbon is chemically combined with the iron instead of being in the state of graphite.

Gray cast iron contains much of its carbon in the condition of graphite, so that the cast iron itself is a conglomerate of this free or graphitic carbon mechanically mixed with the remainder or metallic part of the mass, which may be called the "matrix."

Mottled cast iron is intermediate in composition between gray and white cast iron, having part of its carbon free or graphitic, and the rest chemically combined with the iron.

Of these three kinds of cast iron, the gray is by far the softest and least brittle, the white is the hardest and most brittle, while the strongest cast iron is between the extremes of the grayest and the whitest.

Gray cast iron may be as soft as the low-carbon steels, and white cast iron may be as hard as and perhaps harder than any even of the high-carbon steels; but all these cast irons are both weaker and more brittle than either low or high-carbon steel. Thus all cast irons are weak and brittle, but some are very soft and others very hard.

Figure 1 shows in a general way these three important physical properties, the strength, ductility, and hardness of these three classes or iron (for the moment leaving gray and mottled cast iron out of sight), and how these properties are related to the carbon content. The whole may be summed up by saying that as the carbon increases, the hardness increases and the ductility decreases, both without limit; but that the tensile strength reaches a maximum with about 1.00 or 1.20 per cent of carbon, and decreases with farther increase of carbon.

Wrought Iron.—The members of the weld-metal class contain a small quantity (usually from 0.20 to 2.00 per cent) of slag or cinder, (in this case a very basic silicate of iron oxide), because they are made by welding together pasty particles of metal at a very high temperature, in a bath of this slag, without subsequent fusion or other means of expelling it completely. Of this series the only member today of importance is wrought iron, which usually contains only a very little carbon. Its characteristic structure is shown in Figure 3, in which the black streaks are little rods of slag drawn out in the process of rolling or hammering the balls in which the wrought iron is first made into bars or sheets. The remainder of the mass is essentially made up of separate crystals of nearly pure iron or "ferrite," interfering with each other and hence misshapen. The differences in tint are due to differences in the way in which different crystals are acted upon by the nitric acid or other reagent with which the specimen is etched, differences which in turn are due to such causes as difference in orientation, i. e., in the direction of the axes and cleavage of the different crystals.

Wrought iron differs from the low-carbon steels, e. g., from those used for making rivets, fencing wire, and the sheet iron used for conversion into tin plate by coating with tin, essentially in containing this small quantity of slag. Such steel is practically free from slag, for the simple reason that it is cast in a very fluid state into ingots or other castings, and that this fluidity enables any slag present to separate by rising to the surface by gravity. The carbon content of wrought iron and of such steel is substantially the same, and hence their properties are closely alike, save in so far as those of wrought iron are affected by the presence of this small quantity of slag. As such steel is actually made, it usually contains rather more manganese but less phosphorus than most wrought iron; this gives a slight further difference in properties between most wrought iron and most of such steel; but this difference is neither necessary nor essential.

Definitions.—In considering the foregoing classification we note that there are two distinct bases for the name steel. The "weld-steels" are called steel because they differ from wrought iron in containing a considerable quantity of carbon, and from cast iron in being malleable; the low-carbon steels are called steel because they differ from wrought iron in being slagless, and from cast iron in being malleable. This confusing nomenclature must be endured, at least for the present.

However, the matter is not so bad as it looks at first. The weld steels are unimportant. The three important classes are wrought iron, steel, and cast iron. Wrought iron is readily and almost sharply distinguished from the others by its containing slag. And, fortunately, there is one criterion which we may adopt for discriminating between all the various classes of steel on one hand and those of cast iron on the other, a criterion which we may apply to all future varieties of iron when we seek to decide whether they ought to be called steel or cast iron. This criterion is malleableness in at least some one range of temperature; we may adopt it because such malleableness is probably the only important specific property which all steels of today have, and all cast irons of today lack, if we except the special product known as "malleable cast iron," which really stands in a class by itself, through its genesis, constitution and properties. In the following scheme of definitions this criterion is used.

Wrought iron, slag-bearing, malleable iron, which does not harden materially when suddenly cooled.

Steel, iron which is malleable at least in some one range of temperature, and also is either (*a*) cast into an initially malleable mass; or (*b*) is capable of hardening by sudden cooling; or (*c*) is both so cast and so capable of hardening. (Tungsten steel and certain classes of manganese steel are malleable only when red-hot.)

Cast iron, iron containing so much carbon or its equivalent as not to be malleable at any temperature.

Malleable cast iron, iron which when first made is cast in the condition of cast iron, and is made malleable by subsequent treatment without fusion.

Alloy steels and *cast irons* are those which owe their properties chiefly to the presence of an element (or elements) other than carbon.

Ingot iron, slagless steel containing less than 0.30 per cent of carbon.

Ingot steel, slagless steel containing more than 0.30 per cent of carbon.

Weld iron, the same as wrought iron. The term is little used.

Weld steel, slag-bearing varieties of iron malleable at some temperatures, and containing more than 0.30 per cent of carbon. It differs from wrought iron only in containing more carbon.

These definitions cover not all conceivable but simply the present important classes of iron. Should others later become important, their nomenclature may then be determined.

Source of the Confusion in Our Nomenclature.—It may be of interest to expose in passing the way in which much of the confusion in our present nomenclature has arisen, both to show the student from

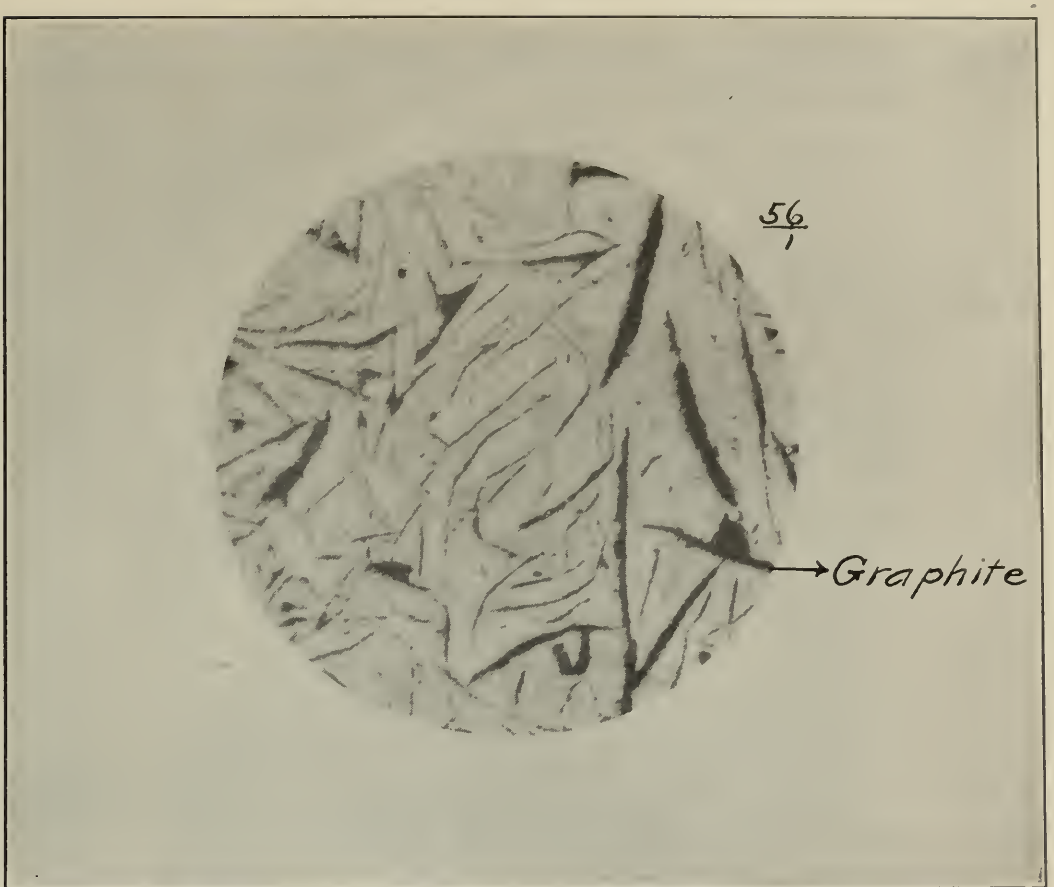


FIG. 2. GRAY CAST IRON, CAST IN SAND.

what motives these systems may arise, and also to give warning of the sort of trouble which is likely to arise in case we give names based, not on essential and definitive properties, but on accidental ones which are not definitive, no matter how important they may be.

Until about 1860 there were only three important classes of iron—wrought iron, steel and cast iron. The essential characteristic of wrought iron was its nearly complete freedom from carbon; that of steel its moderate carbon content (say between 0.30 and 2 per cent), which, though great enought to confer the property of being rendered very hard by sudden cooling, yet was not so great as to make the metal brittle when cooled slowly; while that of cast iron was a carbon content so high as to make the metal brittle whether cooled quickly or slowly. This classification was based on carbon content, or on the properties which it gave. Wrought iron, and certain classes of steel which then were important, necessarily contained much slag or "cinder," because they were made by welding together pasty particles of metal in a bath of slag, without subsequent fusion. But the best class of steel, crucible steel, was freed from slag by fusion in crucibles; hence its name, "cast steel."

Between 1860 and 1870 the Bessemer and open-hearth processes introduced a new class of iron, today called "mild" or "low-carbon steel," which lacked the essential property of steel, the hardening power, yet differed from the existing forms of wrought iron in its freedom from slag, and from cast iron in being very malleable. Logically it was wrought iron, the essence of which was, that it was (1) "iron" as distinguished from steel, and (2) malleable, i. e., capable of being "wrought." This name did not please those interested in the new product, because existing wrought iron was a low-priced material. The only justifiable alternative would have been to assign a wholly new name to the wholly new product; but as steel was associated in the public mind with superiority, it appeared more attractive to appropriate its valuable name. This was done with the excuse that the new product resembled one class of steel—cast steel—in being free from slag; and, after a period of protest, all acquiesced in calling the new product "steel," which is now its firmly established name. The old varieties of wrought iron, steel, cast steel, and cast iron preserve their old names; the new class is called steel by main force. As a result, certain varieties, such as blister steel, are called "steel" solely because they have the hardening power, and others, such as low-carbon steel, solely because they are free from slag.

The Microscopic Constituents of Iron and Steel.—The great advance which has taken place in our knowledge of the constitution of steel and the other varieties of iron has shown that they resemble very closely the igneous and metamorphic rocks, i. e., exactly those which, like the different varieties of iron, have formed from the cooling of molten or at least pasty masses. Just as a granite on close examination is seen to consist of an aggregation of crystalline fragments of mica, quartz, and feldspar, each of which is a definite chemical compound, with definite crystalline form and definite physical properties in general, so the microscope shows us that a given piece of steel or iron usually consists of extremely minute crystalline particles of two or more substances, each of which is a definite entity, with definite chemical composition and definite physical properties.

But besides the granitic type, certain varieties of iron seem to represent the obsidian type. In this, as in aqueous solutions, the ratios in which the different chemical substances, the silica, lime, etc., exist are not fixed or definite; they vary from case to case, not *per saltum,* as between definite chemical compounds, but by infinitesimal gradations. The different substances present appear to be dissolved, as it were, in each other in a sort of solid solution which has the indefiniteness of composition, the incapacity of being resolved by any magnification of the microscope, and the feeble chemical attraction between the different components, characteristic of a solution.

The schistose structure of rock masses, their columnar or basaltic structure arranged in columns perpendicular to the cooling surface, their "vugs" or cavities lined with specimens of free crystals, their segregation, etc., are reproduced in a most interesting way in metallic masses.

FIG. 3. WROUGHT IRON FORGED. LONGITUDINAL SECTION.

With the exception of the rods of slag shown in black, the whole of the mass consists of crystals of ferrite interfering with each other and therefore irregular in shape.

Of these different microscopic entities which constitute the different varieties of iron, only the following here need consideration:

1.—Ferrite, the microscopic particles of nearly and perhaps perfectly pure metallic iron. It is magnetic, very soft and ductile, but relatively weak, with a tensile strength of about 45,000 pounds per square inch. It is of the isometric system. It always forms a very important part of slowly cooled iron and steel in general (excepting the alloy classes).

When much slag is present, as in wrought iron, and is drawn out into fibers by rolling, the mass as a whole is thereby given a certain kind of pseudo-fibrousness; but even here the metallic or ferrite quasi-fibers usually consist of an aggregation of grains, each of which is equiaxed. (See Figure 3.)

2.—Cemenite, a definite carbide of iron, Fe_3C, containing 6.67 per cent of carbon, very brittle, harder than hardened steel, scratching glass and feldspar but not quartz, ($H = 6$), and magnetic. The carbon in slowly cooled steel is chiefly or wholly present as cementite, of which there is therefore $(56 \times 3 + 12) \div 12 = 15$ per cent for each per cent of carbon present. In slowly cooled cast iron, too, it is probable that all or nearly all of the combined carbon as distinguished from the graphite is present as cementite. It is one of the constituents of pearlite, and is an important constituent of slowly cooled iron and steel in general, of course excepting the varieties which are nearly free from carbon. Its carbon is often spoken of as *cement carbon*, and is the *carbide-carbon* of Ledebur.

Cementite

Austenite

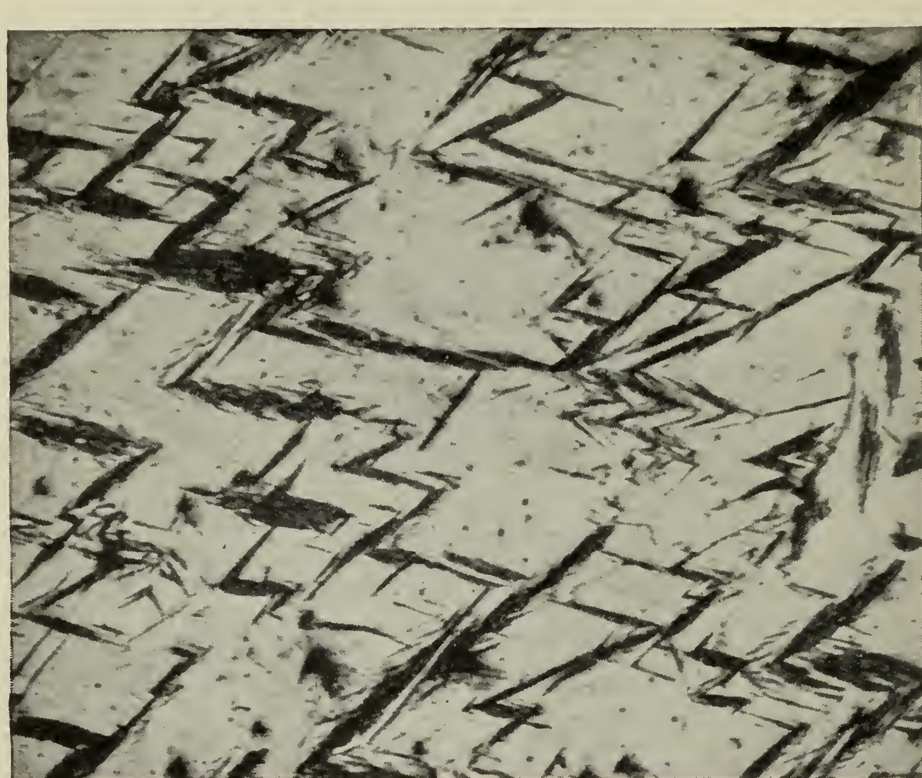


FIG. 4. CEMENTITE IN AUSTENITE. CEMENTED CARBON STEEL.

Carbon about 1.50 per cent. Quenched at 1050° C. in ice-water.

Figure 4 shows cementite associated with austenite in a suddenly cooled high-carbon steel. The black zigzag constituent is the cementite, the white ground mass is the austenite. While this is not the habitual shape in which cementite is found in the varieties of iron with which we are most familiar, it is nevertheless probably idiomorphic, if we may judge from the conditions under which it came into existence.

3.—Pearlite, consisting of interstratified plates of ferrite and cementite, in the ratio of about six parts by weight of the former to one of the latter, as inferred from its containing about 0.90 per cent of carbon. The exact composition of pearlite is still in dispute, and I adopt this number of 0.90 per cent only provisionally and for the purpose of fixing our ideas.

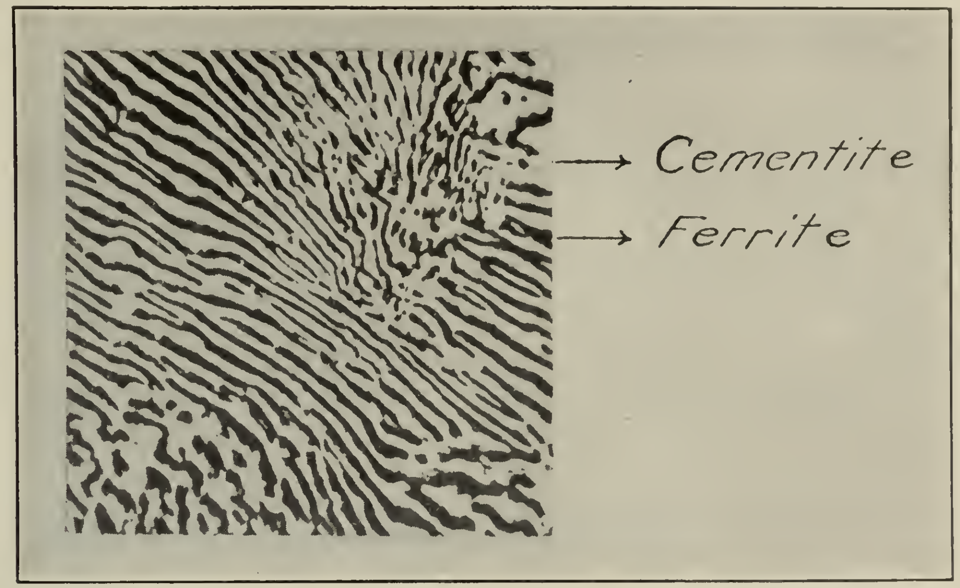


FIG. 5. PEARLITE, STEEL (CARBON ABOUT 1 PER CENT.) FORGED AND ANNEALED AT 800° C.

Slowly cooled steel consists essentially of a conglomerate of this pearlite plus the excess-substance, which is ferrite if the carbon-content is below 0.90 per cent, but is cementite if it is above 0.90 per cent. Paraphrasing Osmond, steel may be called "æolic," "hyper-æolic" or "hypo-æolic," according to whether it contains just 0.90 per cent of carbon, or more than that or less.

Slowly cooled cast iron probably consists essentially of a conglomerate (1) of pearlite with its accompanying excess of either ferrite or cementite according to whether the combined carbon is less or greater than 0.90 per cent, and (2) of graphite.

Figure 5 shows the structure of pearlite. The black stripes are the ferrite, which, although itself white, here looks black owing to the conditions of preparing and illuminating the specimen.

4.—Austenite, the characteristic and chief constituent of suddenly cooled, i. e., "hardened" steel, is a hard, brittle mass, with a needle-like structure, and is a solid solution of carbon in iron, the proportion of carbon varying from nothing up to about two per cent. Its hardness and brittleness increase with its carbon content.

Martensite, troostite and sorbite are transition forms between austenite on one hand, and ferrite and cemenite on the other, probably containing all three of these substances, but in varying proportions. They need not be considered in the present elementary discussion.

Summary.—To recapitulate, the chief constituents of the iron-carbon compounds, the steels and cast irons, are:

1.—In the slowly cooled state of both steel and cast iron, *pearlite,* a conglomerate of (2) the soft, weak, ductile *ferrite,* and (3) the hard brittle *cementite,* in the ratio of 6:1, together with whatever excess of ferrite or cementite is present over and above this ratio.

4.—Also in the slowly cooled state of cast iron, *graphite,* a non-metallic and as it were foreign body,

5.—In the suddenly cooled state of both steel and cast iron, *austenite.*

We may classify all our iron-carbon compounds, all our steel and cast irons, according to this grouping.

GREAT ELECTRIC INSTALLATIONS OF ITALY.

By Enrico Bignami.

THE ROME-TIVOLI POWER PLANT AND TRANSMISSION.

The installation described by Signor Bignami is interesting as a combination of steam and water power in the same service—the hydraulic source having been brought in to supplement the boiler plant when modern conditions made larger demands for power, and modern developments made it economical to transmit it electrically over greater distances. It is a sort of concrete instance of one of the important tendencies of the times in mechanical and electrical engineering. And it is interesting further because the instance is supplied by a country which is poor in engineering industries, and must call upon foreign manufacturers for the necessary equipment. In this aspect, it epitomises one of the most important commercial developments of the times.—The Editors.

THE fame of the falls of Tivoli runs far back into history, and even in the middle ages their power was utilised in small manufacturing operations. It was natural, therefore, that Tivoli should have been the site of one of the first hydro-electric stations; and this plant—on the Gaulard and Gibbs system—imperfect as it may have been, is worthy of recognition for its historic interest from the point of view of the distribution of alternating currents by means of transformers in parallel. Here is the site for a monument to the memory of Emile Gaulard, for here was the first installation for the distant transmission of electric energy by his system, from which have developed the systems now in use, and upon which as a foundation also were built the profound and admirable studies of Galileo Ferraris.

The present Tivoli plant was started in 1892 by the Società Anglo-Romana, which has a monopoly of gas and electric lighting until 1928. The original installation was replaced later by four groups of 3,300 kilowatts each, and enlarged and completed now by the addition of three more units of the same size, making a total of 23,100 kilowatts. Turbines and dynamos were supplied by Ganz & Co., of Budapest. Each group is made up of a triphase generator of 3,300 kilowatts at 10,000 volts, direct-coupled to the shaft of its corresponding turbine.

On account of the existing monophase distributing network, and

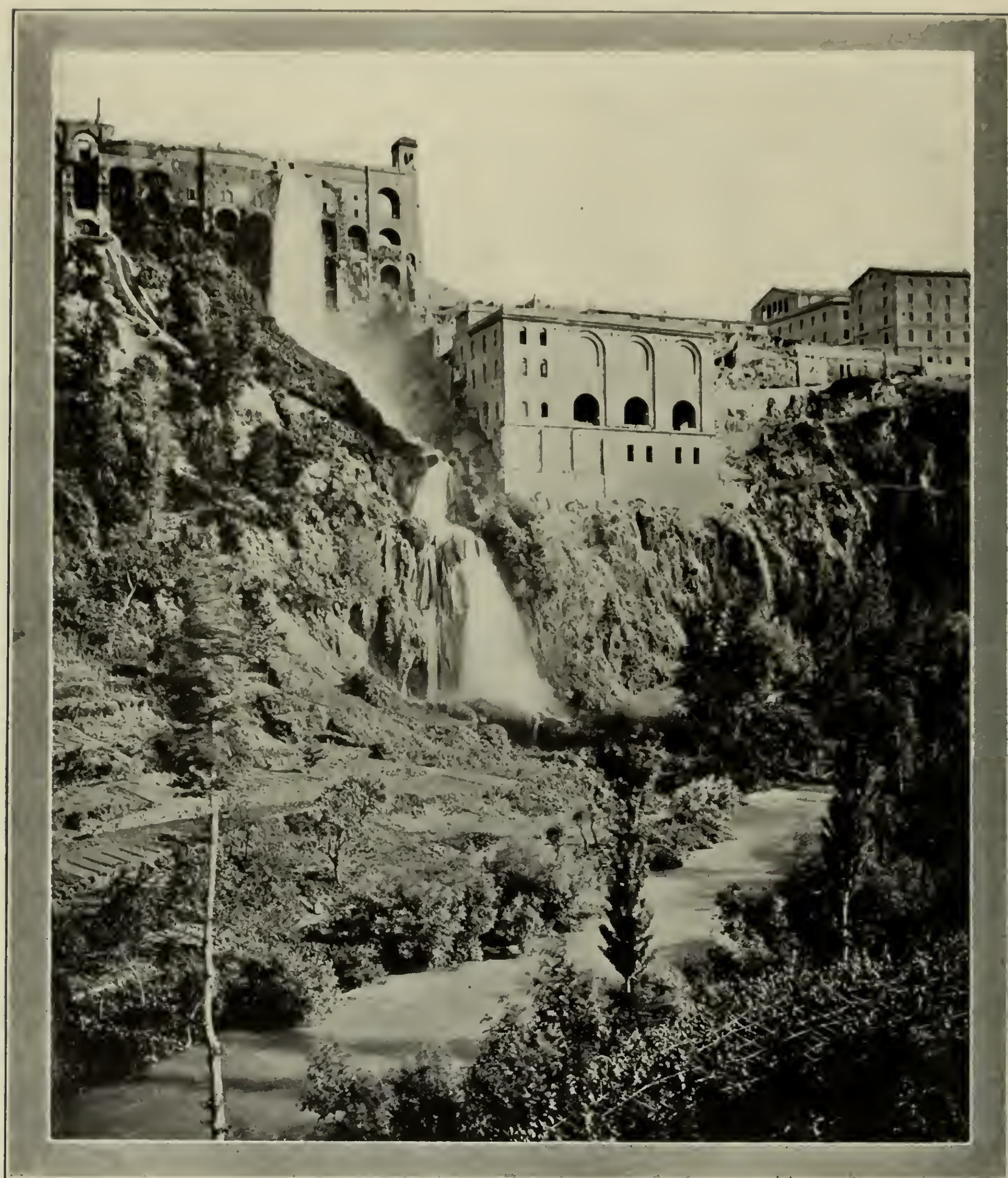


FIG. I. THE CENTRAL STATION AT TIVOLI.

also of the fact that the business done will not yet admit of a regular triphase service, the dynamos have been designed so that they can also generate monophase current and in so doing use all the available power of the turbines.

Each generator has an inductor which is mounted on the main shaft, the latter resting in two bearings and carrying the exciting machine at one end and the flywheel at the other. Surrounding the inductor is the fixed armature, built up of laminated sheet iron. As the generators are direct-coupled to the turbines, they had to be constructed so that if they should rotate at twice their normal speed, owing to derangement of the turbines or to any other cause, they would not be injured. (Figure 13.)

The armature frame is of cast iron, in four symmetrical parts, bolted together, and forms a solid casing so designed as to resist all the stresses to which it may be subjected. The internal diameter of the armature is 4.02 metres; the total weight of the generator is 76,000 kilogrammes, the inductor alone weighing 25,000 kilogrammes.

Each exciter, as already mentioned, is mounted on one end of a generator shaft. It has a cast-iron frame and six poles, and a drum armature with copper-rod winding. The exciters are shunt-wound. Their main current is led directly to the rotating field of the generator, the regulation being effected by means of resistances inserted in the shunt circuit.

FIG. 2. THE ORIGINAL INSTALLATION AT TIVOLI.

In order to facilitate the erection of the machinery, an electric crane was installed.

On the switchboard, each generating unit has its particular section. The high-tension circuits can be broken by means of high-tension switches, and pass through fuse wires to the bus bars which connect all the generators.

The seven groups represent today, reserves included, an output of 23,100 kilowatts, and the Tivoli plant is therefore adequate not only to the present needs of Rome but also to the estimated increase for years to come.

The 10,000-volt current generated at the station is brought to Rome by two aerial conductors 27 kilometres long (Figure 6). A large transformer station at Porta Pia (Figure 7) reduces the voltage in accordance with the several uses to which the power is applied—private consumption, public arc lighting, and the city tramway service.

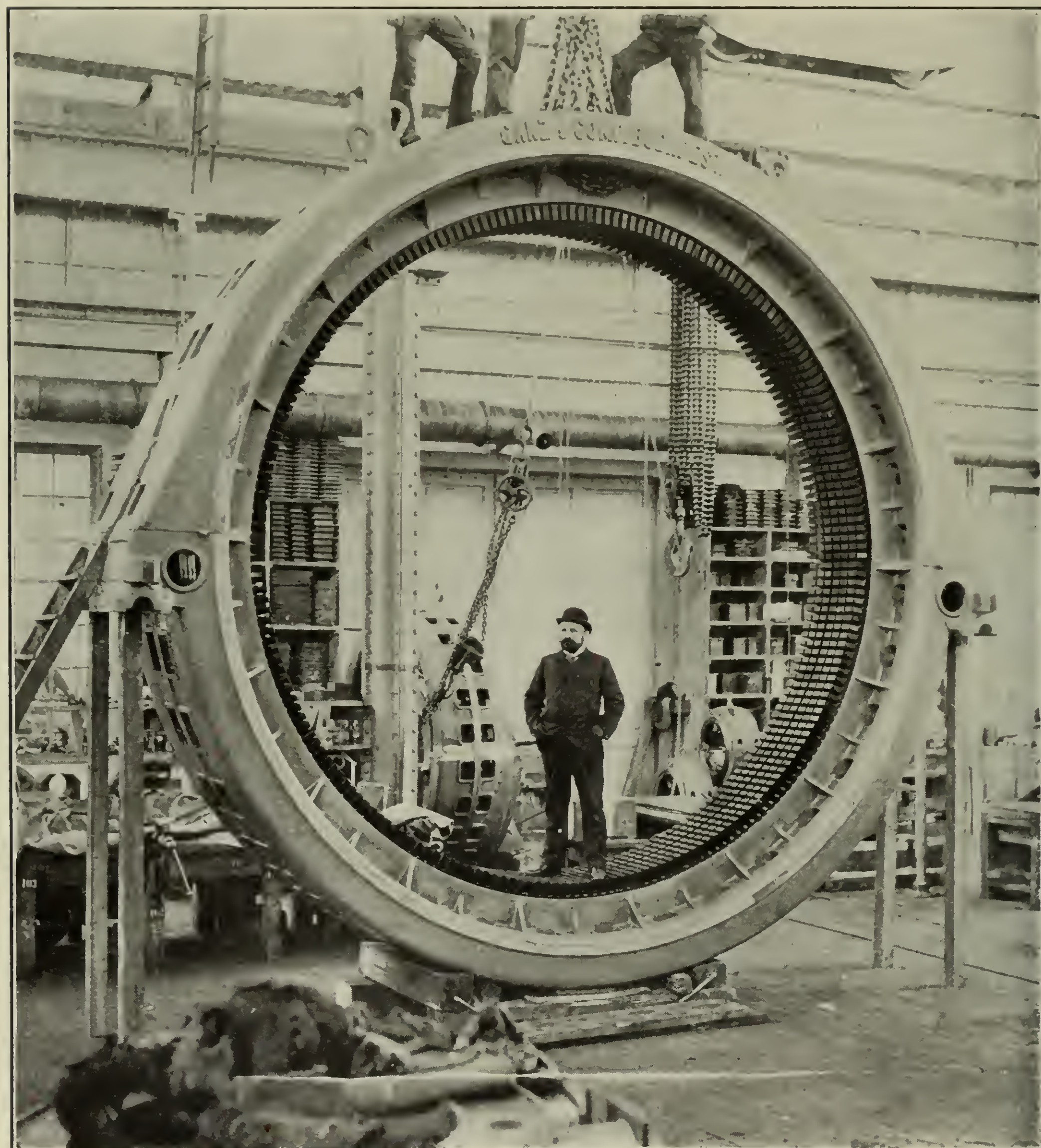


FIG. 3. ARMATURE RING OF A 3,500-KILOWATT ALTERNATOR.

The primary current is therefore distributed to three separate groups of transformers. (Figure 4). One of these reduces the current to 2,000 volts for the private and domestic service—interior lighting and motor applications—which is fed by four concentric cables from the Porta

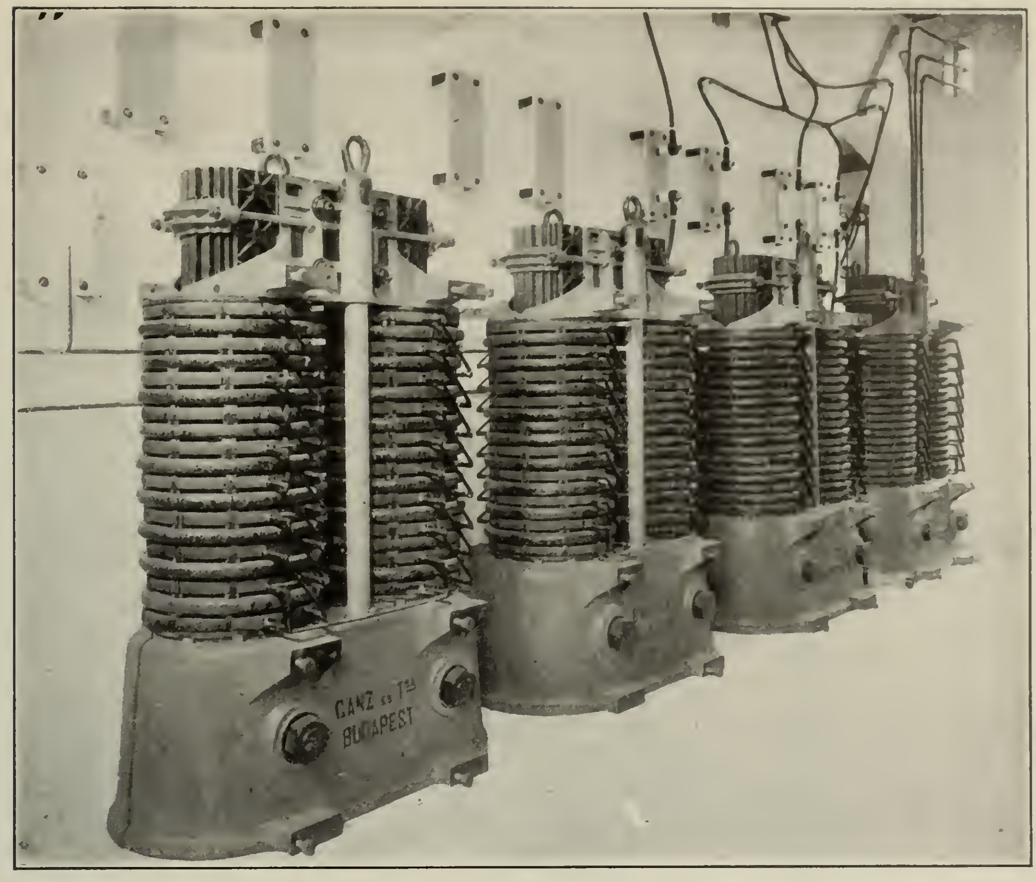


FIG. 4. MONOPHASE TRANSFORMERS AT PORTA PIA.

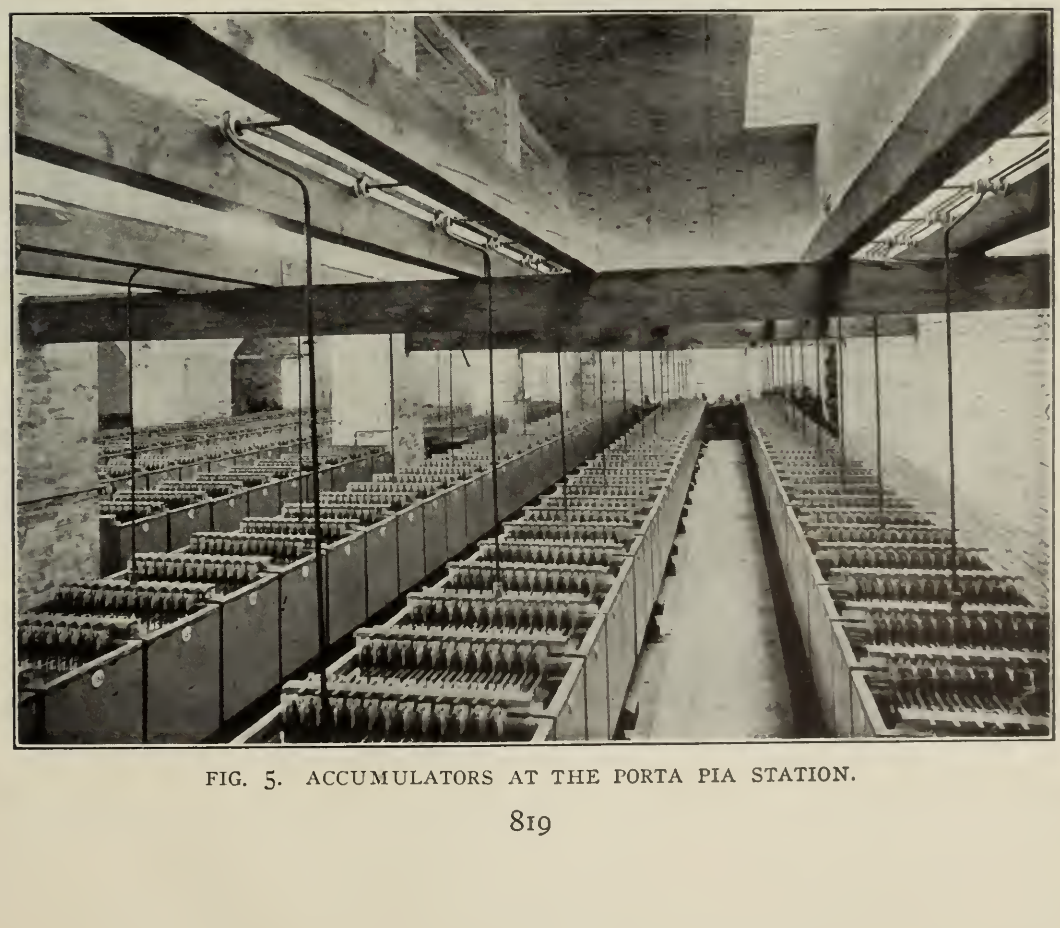


FIG. 5. ACCUMULATORS AT THE PORTA PIA STATION.

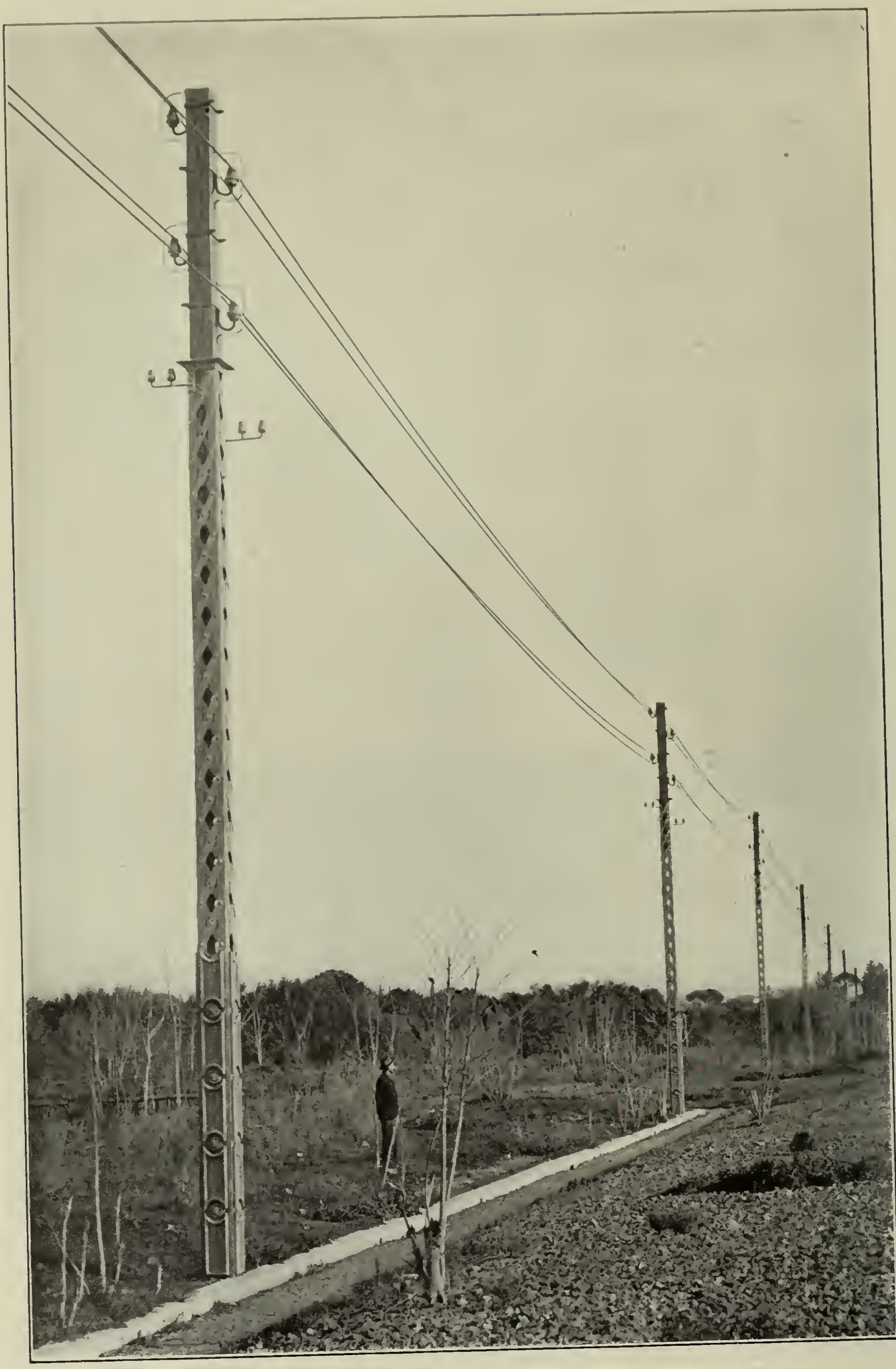


FIG. 6. THE HIGH TENSION LINE AND POLES.

Pia station. The second group also gives a secondary tension of 2,000 volts, but supplies only the system of underground cables connected with the public arc lighting. There are six circuits, each with a maximum of fifty lamps in series, for the illumination of the streets and public places of Rome.

FIG. 7. THE PORTA PIA TRANSFORMER STATION.

A third portion of the primary current from the Tivoli station is transformed and converted by rotaries to direct current at 500 volts for the city tramway service, a large accumulator battery working in connection with the rotaries to equalise the distribution of the direct current. The fourth and last fraction of the power supply goes to four rotaries of special construction, which convert the alternating current into direct current for the tramway system, without the intervention of any static transformer.

A special cable connects the transformer station of Porta Pia with the steam-driven power station of Cerchi, permitting the secondary distributing network of Cerchi to be supplied from Tivoli, and also, in case of need, the Porta Pia circuits to be supplied from the steam power plant at Cerchi. The total output of the latter station is 2,700

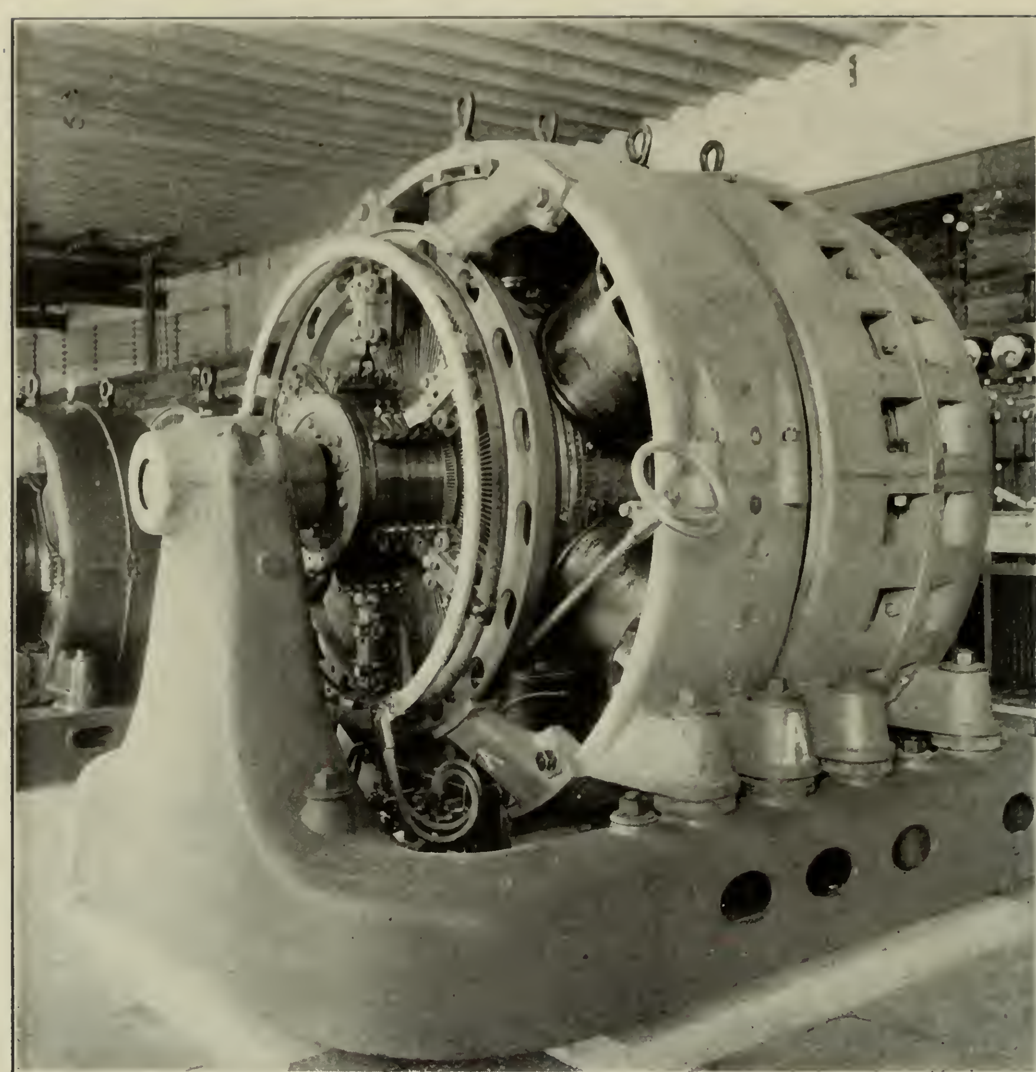


FIG. 8. ONE OF THE ROTARY CONVERTERS IN THE PORTA PIA STATION.

horse power, and the primary circuits (2,000 volts) intersect those of the Tivoli system at many points in the city. At several of these places are switches by which sections of the one system may be connected to one of the stations of the other. The total current output naturally varies greatly with the season, in so large a distributing system, and this arrangement gives entire statisfaction in apportioning the load properly between the two stations.

The Cerchi installation is very important historically, for its plans were prepared in 1885, at a period when alternating current had not been employed except in small isolated plants, and not as yet for distribution over a relatively extended network. The station was finished in 1889, following entirely the lines of the orignal plans.

The electric machinery of this station comprises two alternators of

150 horse power each, and four units of 600 horse power each. There are four continuous-current exciters, direct-coupled to their steam engines. The original portion of the plant, as it was completed in 1886, contained only the two smaller units. It is of interest to observe that all the alternators are of the one type, known as "Type A" of Ganz & Co. It should speak well of the merits of the construction that so many years had rendered necessary only insignificant changes from the original form. These machines are particularly adapted to high-tension service.

The regular development of the electric lighting of Rome began in 1886 and this plant is probably the first high-tension alternating-current station in the world with underground distributing mains and transformers in parallel. It worked with so favourable results that soon a considerable enlargement was determined upon. In the second half of 1887 two of the large alternators driven by 600-horse-power engines were put in, and a little later the other two. As the alternators may run in parallel or independently, as special conditions may dictate, four rheostats of the Blathy type are installed to insure constant tension. Each one may be connected to any one of the alternators.

The conduits proceeding from the Cerchi station carry four feeders, which are supplied (as conditions of distribution may require)

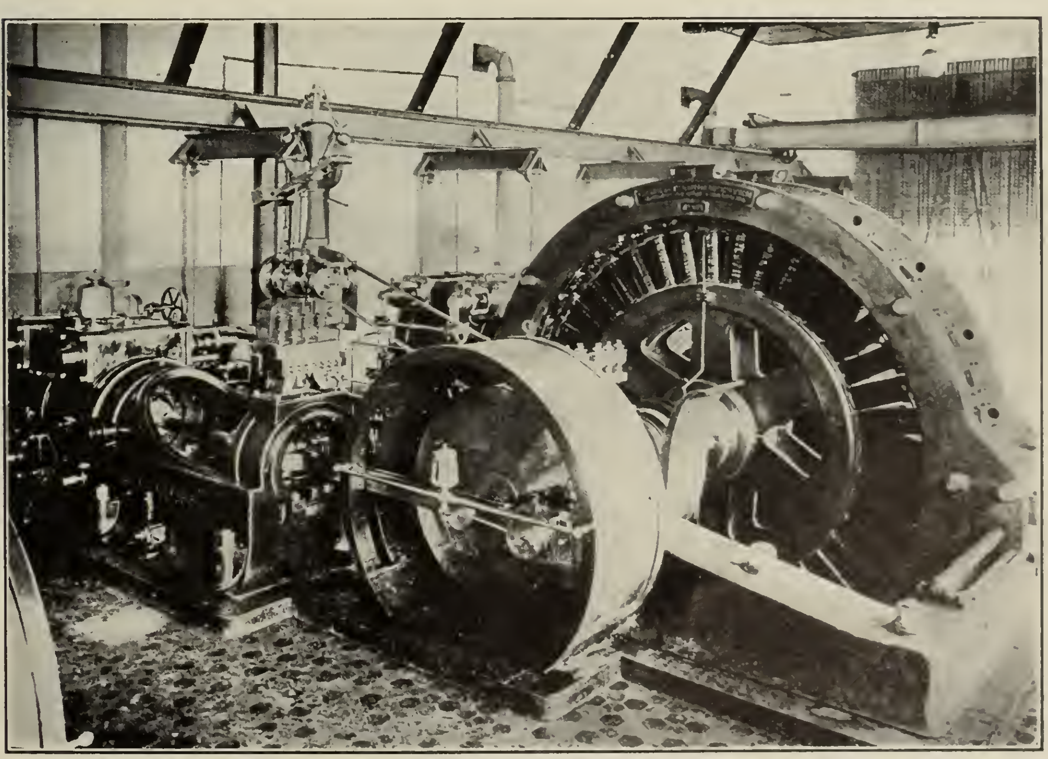


FIG. 9. THE CERCHI POWER HOUSE.

separately or in parallel by the corresponding alternators. Service conditions often necessitate some change in the particular machines to be kept in operation—perhaps the substitution of one generator for another—without interruption of the service. To this end Mr. Blathy has devised a special switch which permits any one of the six generators to be thrown instantly into the supply of any one of the four feeders. The construction of the switch is highly ingenious and it forms one of the characteristic features of the Cerchi plant.

The transmission line which, as already mentioned, connects the Tivoli station with the Porta Pia transformers, may be connected with any part of the Cerchi circuits by a special switch which connects it with the switchboard. In this case the corresponding steam-driven dynamo is cut out from the bus bars.

In spite of the repeated enlargements of the Cerchi station, it remains inadequate to the constantly rising demands for electric current, and it is on this account that the Tivoli water power was called in to aid.

The course of the transmission was practically dictated by the antecedent location of the conduit for water, connecting Tivoli with Rome across the Campagna Romana. The electric and hydraulic lines parallel one another for almost the entire distance. Leaving the central station, the electric transmission line descends toward the River Anio, (which falls about 165 feet lower than the level of the station), crosses the river, climbs a hill, traverses a great olive plantation, and meets the Marcia hydraulic canal. This it follows to a point near Mount Mammolo, thence diverging by a shorter line to Rome. (Figure 10). At different points on its course the transmission line crosses the railways from Rome to Solmona, from Rome to Orte, and the State telegraph lines. At all these crossing points safety devices are installed to prevent accident from the breakage and fall of a high-tension wire. The Anglo-Romano gas company has secured a strip 9 feet in width the whole length of the right of way, to provide for the erection of another pole line for the future enlargement of the undertaking. Half way to Rome is a small building called the "*capannacce*." (Figure 11). It is not only a shelter for the line patrol, but a store house for material and for the repair tools and apparatus. Here also electric measurements may be made, the nearest pole being provided with sectional insulators interrupting the continuous line from Tivoli to Rome. Lightning arresters are also provided. On most parts of the line the poles are of metal, lattice form, as shown in Figure 12. The telegraph and telephone wires are fixed on the metal part of the poles, phosphor

FIG. 10. THE TRANSMISSION LINE ON THE CAMPAGNA ROMANA.

bronze being used both for direct and return circuit. To avoid induction, the wires are alternated every ten poles—that is, every 1,500 feet. The absolute potenial of the telephone line is quite high, so that one touching it, if in contact also with the ground or the pole, would receive a very disagreeable shock. Thus the telegraph and telephone wires, placed below the four high-tension wires, act as sentinels against the danger of coming in contact with the high-tension transmission. There are four small telephone stations along the line, so that the watchmen can communicate promptly with the head stations.

The line leads, as already stated, to the transformer station of Porta Pia, shown in Figure 7. This station contains two parts, one containing the transformers, the other containing the switchboards, control apparatus, and automatic rheostats. The transformers are show in Figure 4. They are of the latest Ganz type, and their iron cores are in two parts. Each part is built up of iron sheets in the form of an E, held together by circular end plates with a diameter great enough to allow the transformer to be rolled on the ground, thus facilitating their handling. One of the end plates carries the primary and secondary terminals. Each conductor has its own fuse, which is mounted on the wall of the transformer room, and can be replaced even during the regular operation of the plant.

The transformers are divided into two groups, one for the private service distribution, the other for the public lighting. The street arc lamps are set at distances of 130 to 160 feet apart, and elevated from 25 to 30 feet above the ground. Each lamp takes 14 amperes at about 35 volts. They are all of the Zypernowsky type, burning 14 hours without renewal of the carbons.

Four separate concentric cables supply the private consumers of light and power, the distribution being made, as already said, under a pressure of 2,000 volts. For the 102-volt incandescent lamps and 51-volt arc lamps in parallel used by consumers on these circuits, low-

FIG. 11. THE "CAPANNACCE"—MEASURING AND LINE-PATROL STATION ON THE LINE FROM TIVOLI TO ROME.

FIG. 12. ONE OF THE POLES, SHOWING TRANSMISSION CABLES, TELEGRAPH AND TELEPHONE WIRES.

tension current is provided by transformers distributed along the length of the cables. These are similar in construction to those in the main station at Porta Pia, a constant ratio of transformation of 1 to 18 being maintained throughout the system.

The secondary distribution in alternating-current systems is usually effected either by a high-tension primary with individual transformers, or else by a network of low-tension circuits supplied by groups of transformers disposed in sub-stations at convenient distances. After thorough trial, extending over several months, Professor Mengarini arrived at the conclusion that the greatest advantage lay with the method involving the installation of a number of secondary substations, each with a network wholly separate and distinct from the others. This might be regarded as an intermediate between the individual-transformer and the low-tension-secondary systems. Each sub-

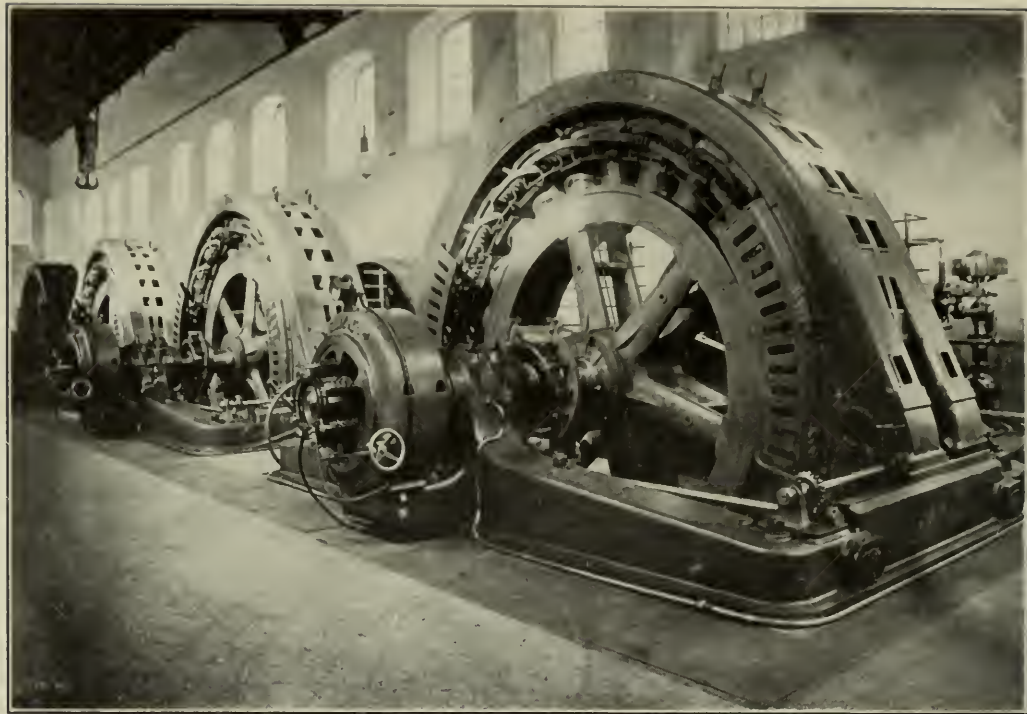


FIG. 13. 3,300-KILOWATT ALTERNATORS IN THE NEW TIVOLI POWER STATION.

station is supplied with primary current at 2,000 volts, and supplies a small three-wire sub-system with 102 volts between the wires.

When the company undertook to supply power for the tramways of the city—some 36 kilometres—a considerable enlargement of the Porta Pia station became necessary. Twelve new transformers (1 to 10) were installed especially for the tramway service, and in addition two large rooms were built for the rotary converters, and two for the accumulator batteries.

The Società Anglo-Romana, which is now the concessionaire of the tramways also, had on its systems on December 31, 1902:

148,318 lamps of all powers, corresponding to 147,002 lamps of 16 candle power.

605 transformers, of which 554 were the property of the company.

2,853 meters.

1,500 kilowatts rented to 252 subscribers for power. Other small motors, especially fans, are in use by patrons of the lighting service.

1,134 arc lamps, of which 260 are assigned to the public lighting of Rome, still for the most part effected by gas.

3,000 kilowatts for traction purposes on 36 kilometres of tramway.

Comparison with the figures for 1901 shows that the increase in the use of electric light continues, and that there is a very marked advance in the use of electric power.

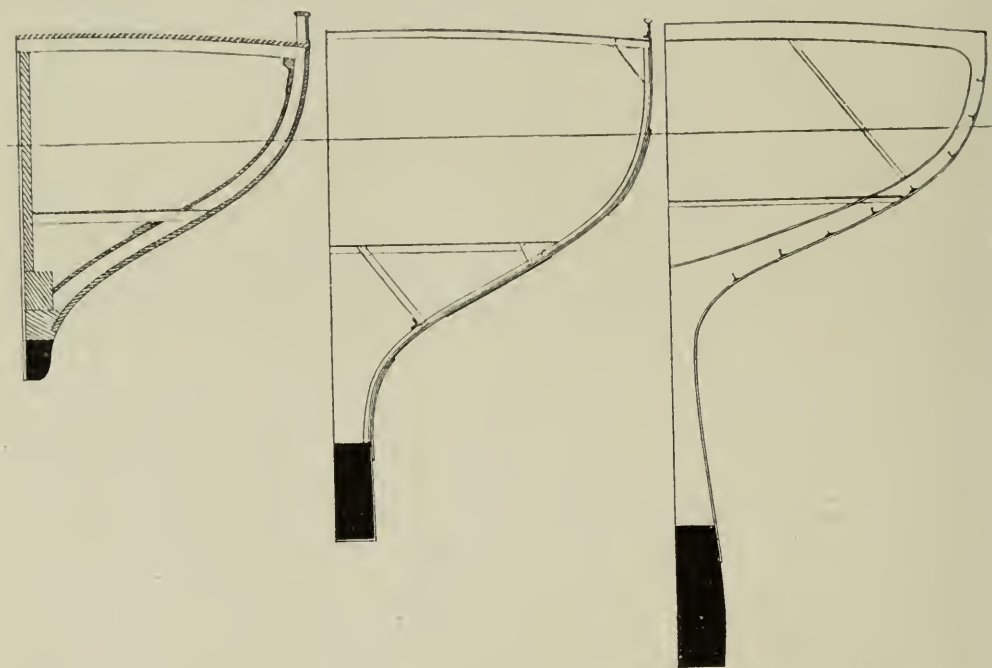
THE MODERN RACING YACHT AN ENGINEERING PROPOSITION.

By W. P. Stephens.

The keynote of the conception which has made the modern racing yacht an engineering proposition is expressed in Mr. Stephens' statement that "speed is merely a question of horse power per ton of displacement." This reduces the whole thing to a refined problem in marine powering and bridge building. The rapid progress under this realization, and the tendency of exact scientific methods to lead all designers to a single type, are most interestingly told in the following article.—The Editors.

IN the great game of yacht sailing just being played outside Sandy Hook, there is one feature above all others which appeals to every one of the many thousand spectators, striking with equal force the practical yachtsman and most casual looker-on. The towering spars and enormous area of canvas on each contestant are so far in excess of anything previously seen over any hull of similar size as to challenge the attention of the greenest landsman. The result of these great sail plans is simply power in excess, out of all normal and reasonable relation to the elements of the hull, and it is only through such excess of power that a comparatively small gain in actual speed is possible. There is nothing more difficult to measure than the true speed of a large sailing yacht, as she may race for an entire season without once realizing that peculiar combination of conditions which will put her at her best; in default of reliable figures we may assume that the speed of the first of the great class of 90-foot Cup defenders, Puritan, was about 12 knots, and that the modern representatives of the class are capable at the utmost of 15 knots. To attain this increase of 25 per cent., certainly a liberal one, the length on the waterline has been increased from 81 feet to 90 feet, 11 per cent.; the displacement has been increased from 105 tons to something under 150 tons, or about 40 per cent.; while the sail area has risen from 7,300 square feet to 16,000 square feet, or an increase of nearly 120 per cent. Incidentally, while the cost of the modern Cup racers is known only to owners, designers, and builders, it is safe to say that the wooden Puritan, today in use as a cruising schooner, cost less than one-tenth of the bronze Reliance whose value in a very few years will be only that of scrap metal.

While George Steers, the modeller of the first Cup winner, the schooner America, in 1851, was a man of remarkable ability and originality, a leader among the old-time shipwrights for which New York was once famous, the designing and building of yachts was until a comparatively recent period wholly in the hands of men who were merely ship-builders. The crude method of working from the cut model, the heavy construction, and the clumsy rigging, were but slight refinements on the ordinary practice in commercial craft. The fight of the professional yacht designer, planning everything in advance over his drafting table, against the rule-o'thumb builder working by guess in rough imitation of a cut model, had really been won before

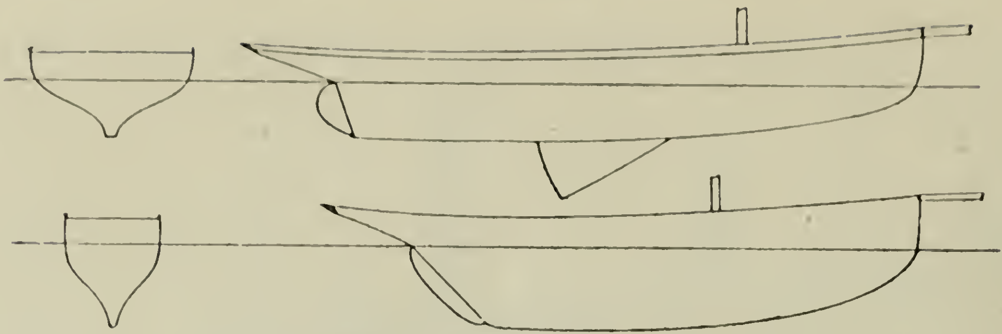


CHANGES IN CUP-YACHT CONSTRUCTION SINCE 1885.
On the left is the centerboard cup defender of 1885; center, the steel yacht of 1885-93; right, the modern 90-foot cup defender.

the building of Puritan; but she and her contemporary, the steel cutter Priscilla, were the first yachts actually designed according to modern methods for the defense of the Cup. In working out deliberately, long in advance of all work of construction, the lines, construction drawings, and details, the arrangement and sail plan, with the accompanying calculations of displacement, positions of centres, stability, and other important attributes, the yacht designer of that day was on a far higher plane than his predecessor, the practical builder; but, at the same time, the work of the two was closely identical in its general scope. In neither the design nor the construction was there any necessity for special skill in engineering as distinct from the usual methods of naval design and construction.

PURITAN AND GENESTA—THE DEFENDER AND CHALLENGER OF 1885.

The relative depth will be better appreciated by taking the figure of one of the bystanders as a measuring unit.



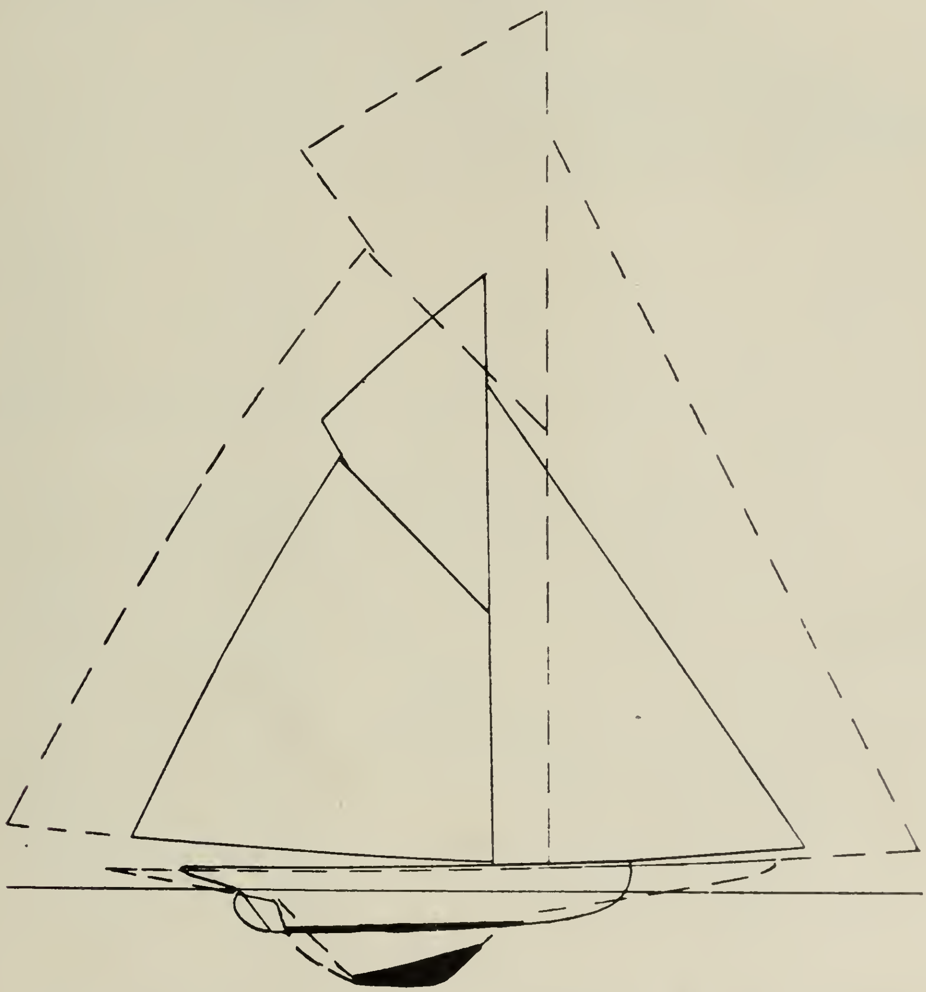
I. THE CUP CONTESTANTS OF 1885.

Genesta, keel cutter, challenger; Puritan, centerboard cutter, defender.

Such a form as that of Puritan could be made amply strong by a very simple construction, merely wooden frames and planking with a few simple longitudinal members such as clamps, shelves, bilge stringers, and ceiling, and either oak or metal floors across the keel. Though heavy in the extreme according to all modern standards, this construction, while both cheap and durable, was far lighter than anything previously known. While the hull itself was subjected to only moderate strains from the sea, it was amply strong to carry without special strengthening the local strains due to the rig and concentrated at such points as the mast step, the shrouds, the runner plates, traveller, and bobstay plates. All of these strains were carried by the hull as a whole through such elementary members as the keel, frames, and planking, without even the aid of the ordinary steel diagonal straps. Above the deck the generous scantling of spars and rigging gave ample strength with the conventional arrangement of members; and, if the weight was excessive, all shared alike in the same handicap.

While British designers had before this begun to cut the weight of construction, under the strong stimulus afforded by the possibility of putting into a deep lead keel every ounce saved from rigging and topsides, neither party had yet been moved to lessen the displacement, and American designers gave little or no attention to the question of weight, contenting themselves with researches in the proportions of breadth and depth, and in the refinement of forms of comparatively large displacement.

The first move in the direction of light construction came from the builders of fast launches and torpedo boats, the Herreshoffs in particular, who early in the eighties awoke to the realization of the truth that, after a certain perfection of form is attained, further increase of speed is merely a question of horse power per ton of displacement. In accordance with this theory a bold cut was made in the scantling of steam launches; single frames of small size, bent from steamed oak, being substituted for the heavy double frames sawn from more or less straight-grained plank; two thicknesses of light wood, white pine or cedar, carefully fitted, laid in white lead and fastened to the frames with brass screws, being used instead of heavy single planking bolted or even treenailed to the big frames and then wedged off with tightly driven caulking. The work of the Herreshoffs for many years was confined almost exclusively to steam craft such as speed launches, fast cruising yachts, and torpedo boats, no small part of their success being due to their bold cutting of the weight of construction.



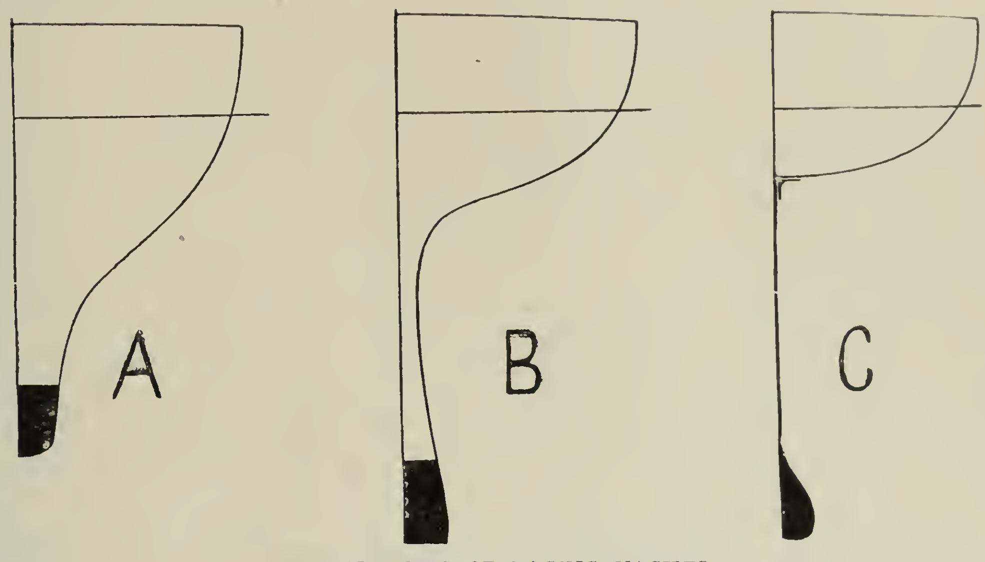
HULL AND SAIL PLAN OF PURITAN COMPARED WITH MODERN 90-FOOTER.

The years 1889 and 1890 were notable ones in yachting; the cessation of the Cup contests in 1887 was followed by a remarkable revival in the smaller classes, the 70-foot and the 51-foot both feeling its effects in a measure. It was in the two still smaller classes, however, the 40-foot and the 30-foot, that the yachts were most numerous and the sport most keen and exciting. The wonderful work of the little Fife cutter Minerva in defeating every American yacht of her class in

PURITAN. GENESTA.

THE CUP CONTESTANTS OF 1885 UNDER SAIL.

1889 and halving the honors with Gossoon, a new Burgess boat specially designed to beat her, in the following year, served to concentrate the attention of both racing yachtsmen and designers on these small classes. When in the fall of 1890, by an unaccountable and unreasonable whim, the 40-foot class was dropped for a new one of 46 feet waterline, Mr. N. G. Herreshoff determined to venture anew in the domain of match sailing and early in the spring of 1891 he launched his famous Gloriana.



MODERN TYPES OF RACING YACHTS.
A, cutter; B, semi-fin-keel; C, fin-keel.

With the same dimensions and displacement as the other boats of the class, Gloriana embodied some marked departures in form, these experiments now being accepted as principles of designing; but no small part of her superiority was due to her improved construction, small light frames reinforced by metal straps and braces, and a double skin that was strong, tight, and gave an almost seamless surface. In the rig, too, were seen many experiments, some since discarded and others elaborated into important improvements. Following closely on Gloriana, launched toward the end of the same summer, came a craft in every way more radical, the famous fin-keel Dilemma.

The fin-keel is an evolution rather than an invention; at a time when ample displacement was still considered an advantage, between 1885 and 1890, the successive work of a British designer, Arthur E. Payne, shows a regular progression of more and more hollow S sections giving a reduction of displacement while both breadth and depth of lead keel were retained to give power, and the fin-keel was rapidly approaching in this way; but to Mr. Herreshoff is due the credit for the first work in the United States, and that in one bold determined step.

The egg was broken, and those who had not yet recovered from the shock of Gloriana were for the moment stunned by the new discovery, the news of the little boat's performances being widely heralded. The evil lessons of light displacement and light construction were soon learned by both yachtsmen and designers and the whole course of yachting was diverted into a new channel.

While the fin-keel soon dominated the smaller classes, the first of the Herreshoff 90-footers, Navahoe, Colonia, and Vigilant, built in 1893, were fairly normal in displacement, form, and construction; though Vigilant was plated with bronze, the first use of this more costly metal, the scantling and the general arrangement of parts did not depart widely from the accepted practice of the day in steel yachts; and the rigs, though very large, were strongly proportioned. With the next Cup defender, built in 1895, Defender by name, Mr. Herreshoff made a radical departure. In model the yacht was a semi-fin-keel, the displacement being reduced, the midship section cut to an extreme wine-glass form, and the lead keel dropped to a great depth—the extreme draft being 19 feet against only 14 feet in Colonia, but two years older. With this altered form was a radical cutting of weights, the scantling being reduced to the lowest limit of safety in all parts, while an extra effort was made to obtain lightness at the sacrifice of durability if not of strength by the liberal use of aluminum plating instead of steel for the outer skin and even the waterways, partner plates, and deck beams. This lightening of the hull proper permitted an increase in the weight of the lead bulb, and this in turn was dropped much lower than ever before, the net result being an increase in stability which permitted a far larger sail plan than on Vigilant or Colonia. The success of Defender over two yachts of widely different type, the trial yacht Vigilant of 14-feet draft of keel and with a centerboard weighing 3½ tons and dropping to a depth of 7 feet, and Valkyrie III with a draft of 20 feet to the bottom of her lead keel, demonstrated the superiority of her type and established certain principles now generally accepted by all who design for the Cup races.

In form this type is best described as the semi-fin-keel, the hull proper resembling a great canoe, of limited depth, and narrow in comparison to the great length due to the excessive overhangs forward and aft. The displacement is reduced to a minimum, the block coefficient of the modern Cup racers being about 0.12 as compared with 0.25 in Puritan. The general form is marked by the convexity of all its lines, there being no hollows, and the fore-and-aft lines, in particular the diagonals, being remarkably long and of fair circular sweep. The power to carry the enormous sail plan is derived mainly from the lead bulb, weighing at least 90 tons, which is suspended at a depth of a dozen feet below the hull. In the smaller classes the "fin" is merely a plate of steel or bronze, attached by means of two angle irons to the keel of the yacht, the lead, in two halves, being bolted to the lower edge of the plate. This construction is inadequate in a 90-footer, and the fin is formed by carrying down the frames and plating to meet the lead, the result being a compromise best described as the semi-fin-keel.

With the acceptance by designers of a certain finality in type, dimensions, and form of hull, there is also a general recognition of two facts:—that displacement must be reduced to a minimum; and that, on any given displacement, a reduction of weight above the top of the fin, and in particular above the waterline, gives added weight in the keel and an increase of sail-carrying power. The problem which the designer has to solve is very largely one in modern engineering, with its expert knowledge of materials; he has a floating body of something under 150-tons displacement which from its dimensions can hardly be of other than good form; beneath this he must suspend by an absolutely rigid connection a weight of at least 90 long tons; above it he must rear a light but immensely strong structure of spars and canvas.

RELIANCE ON THE WAYS, SHOWING UNDERBODY AND FIN KEEL.

RELIANCE, THE CUP DEFENDER OF 1903.

In this work no specific factor of safety is recognized, but every member is worked down to the smallest possible limit which will stand the strain for a brief series of trial and final races.

The old-time yacht builder gave little thought to his materials; white oak furnished him with keel, frames, and part of the planking, with yellow pine for the remainder and for clamps and bilge stringers and ceiling; these being the standard woods. The modern designer is called on at the outset to consider the relative values of metals—nickel steel with its high average of strength for weight, but with a surface

SHAMROCK III., THE CUP CHALLENGER OF 1903.

that is necessarily rough in salt water, bronze, with its almost perfect surface but added weight, aluminum, light, unreliable, and short of life; all present certain advantages and disadvantages. How closely these balance is shown by the fact that the two designers concerned this year, both men of wide experience, have chosen in one case steel and in the other bronze for the plating of the hull; while one deck is of sheet steel and the other of thin aluminum plates. This same question of the strength and weight of material comes up in the selection of steel for some spars and wood for others, of steel wire or manilla rope for the different parts of the running rigging, and in the testing of all kinds and weights of canvas.

Entirely apart from the matter of lines, the hull construction is a special study very closely allied to bridge engineering. The hulls of the old yachts, even including Puritan and Mayflower, may be compared to a plain box of solid boards, deriving its strength solely from the thickness of the wood and the size and number of nails; the hull of a modern racing yacht, small or large, is virtually a floating bridge, subjected to a far greater variety of strains than any fixed structure on land, and deriving the necessary strength within narrow limits of weight solely from the the high quality of material and the complicated and elaborate system of trussing. There is nothing in modern yachting more remarkable than the capture of an international trophy, the Seawanhaka cup, in 1896, by two amateur designers and builders located on an isolated lake, and the successful defense of the cup in eight successive matches; but both of these men are by profession engineers—bridge builders—and it is the successful application of their professional knowledge to yacht designing and practical match sailing which has put them at the very top among modern designers of small craft, professional as well as amateur.

The elements of success in modern match sailing are many and varied but among the more important are the dimensions and the form of hull, the construction, the making of the sails, the tuning up of the yacht by trial races, the generalship which plans the consecutive manœuvres of each race, the personal skill of the helmsman, and the quick work of mates and crew in handling sails. Years of close competition on both sides of the Atlantic have brought British and American yachtsmen into close touch on most of these points; the differences of model are almost superficial; any new details in the rig of one yacht are quickly appropriated by her rival; no one can say to a certainty that American sails are better than the British or the reverse. The skipper of the successful Columbia, winner in two Cup contests, was born in Scotland and obtained his first knowledge of yacht racing in British waters, while the skipper of the third Shamrock has learned much by three previous experiences on the American side. If any one factor can claim the first place in the continued retention of the America Cup by American yachtsmen, it is the daring and skill in engineering by which the designer of Defender, and Columbia—and, we Americans hope, Reliance as well—has produced in each case a lighter hull, and in particular a larger, lighter, and more effective rig than the respective challengers.

THE TOOLS AND METHODS OF A SWISS LOCOMOTIVE WORKS.

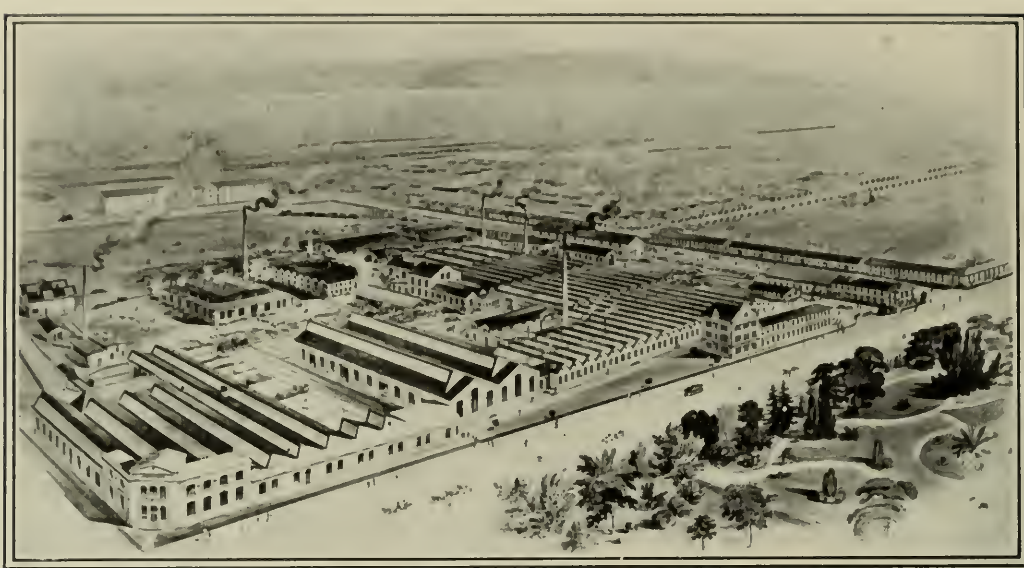
By Charles R. King.

The works described by Mr. King, like those which form the subject of Signor Bignami's article, represent to a considerable extent the transplantation of engineering practice to a foreign soil. In this case, the practice is that embodied in the American, British, and German tools with which the shops are largely equipped, and its fusion with that which is more strictly local forms an interesting study.—The Editors.

IN Switzerland the construction of locomotives has become so much a national industry that at present one single works there has now the monopoly of all orders for the Swiss railways to the exclusion of foreign competitors. The Swiss locomotive is designed with much care, made and built with precision, and the Federal and private railway companies of Switzerland can therefore afford, with a little patriotism thrown in, to keep their orders at home. This is in striking contrast with the custom of a neighbouring country, Italy, where the two principal railways are owned although not exploited by the State, yet locomotives are tendered for by foreign makers without any restriction and not infrequently an order will go *fuori* when the home builders, who are only favoured to the extent of 5 per cent, have been underbidden by merely a few *lire*. Yet it would be a very rash person, outside of an Italian locomotive department, that would dare say that an Italian locomotive was less good in its boiler work or mechanism than a German or Swiss; and there are at least four or five very good locomotive-builders in Italy, while mechanical ability and initiative are not wanting with their engineers.

Winterthur, the site of the Swiss locomotive works mentioned, is really a centre for mechanical industries, with Sulzer Brothers for steam engines and Rieter & Co. for electric generators and hydraulic plant.

Leaving Paris and passing via Basel and then, by a considerable detour, via bleak Zürich, Winterthur—also bleak—is found to be an out-of-the-way provincial town—with still more "provincial"-looking but unpicturesque inhabitants. In such a spot one is led to ask whether the locality was selected by design or at the chance of hazard, and the latter surmise is the one confirmed. For here there is no water power, coal has to be imported principally from Westphalia and costs at pres-



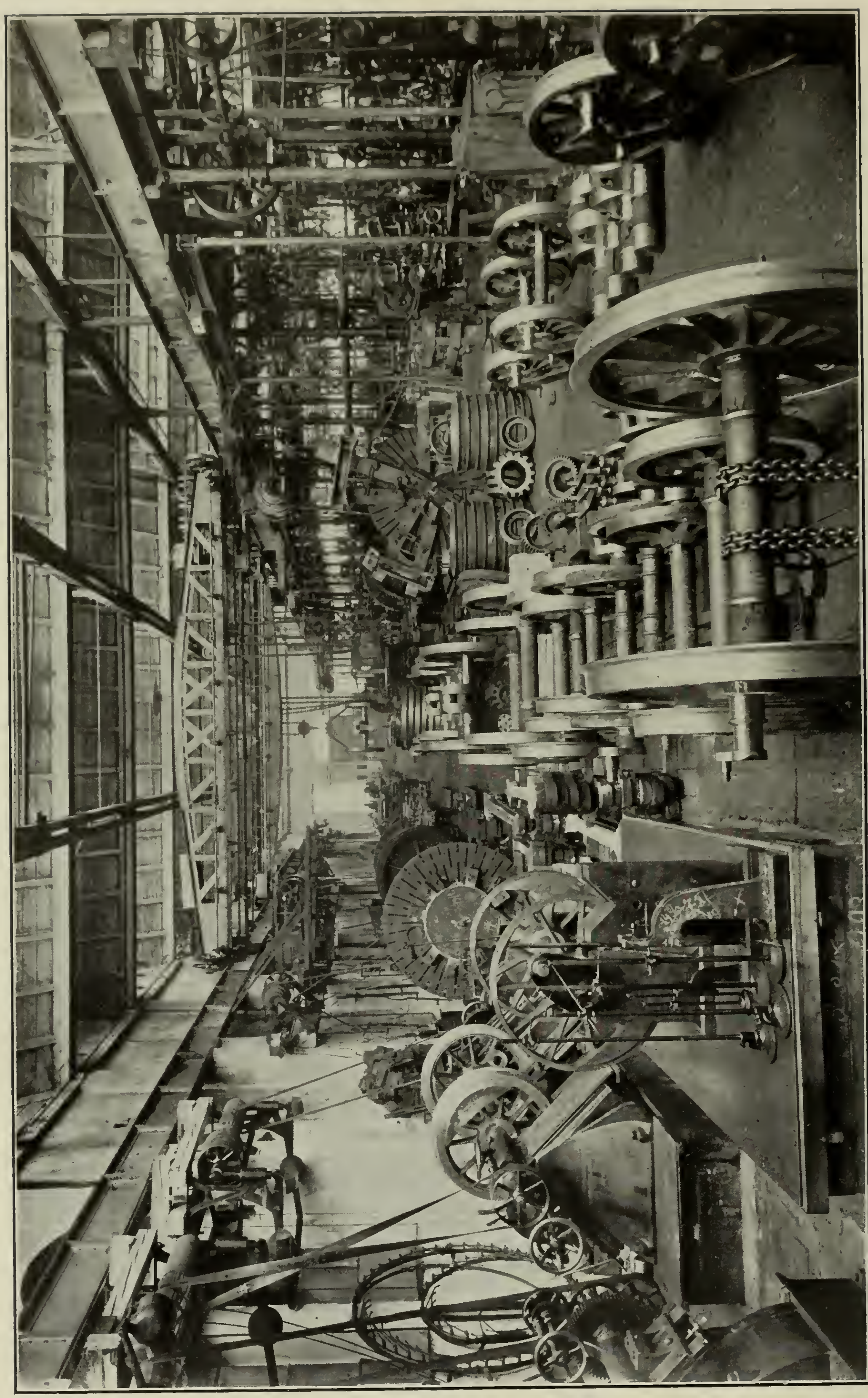
THE SWISS LOCOMOTIVE AND MACHINE WORKS, WINTERTHUR.

ent about 36 francs for the tonne (2220 lbs.) ; iron comes from German iron works, and the natives are not at all suggestive of that natural smartness desirable in machinists; however, despite these unfavouring circumstances, the steam-engine and locomotive works at Winterthur have both a high reputation for fine work.

The locomotive works are situated clear away from the town and about half a mile from the Nord-Ost railroad line to which they are connected by a special track. The buildings are laid out with great orderliness, but excepting that they are modern and with vertical roof lights call for no special remark. The ground on which they are situated has a superficial extent of 88,874 square metres so that there is plenty of space available for future developments. The number of workmen employed is 1,200 and the present annual productive capacity of locomotives is stated to be 100. Taking the twenty-eight years preceding the end of the century the average number of normal-gauge locomotives constructed during that time amounted to 21 per year, or if narrow-gauge and tramway locomotives are added, 45 per year, exclusive of extra boilers and also of the gas engines (200 of all sizes), gas-making plant, and small steam engines and boilers which form an important addition to the output from the Winterthur machine works, to which Italy has so far been the best foreign client for small locomotives.

The motive power available for the shops, but not necessarily developed for daily needs, amounts to about 900 horse power. This is composed variously as follows: one steam engine of 150 horse power

FOUNDRY AND MACHINE SHOP OF THE "SCHWEIZERISCHE LOKOMOTIV & MASCHINENFABRIK," WINTERTHUR.



WHEEL SHOP AND PART OF THE GENERAL MACHINE SHOP OF THE SWISS LOCOMOTIVE AND MACHINE WORKS.

and another of 80 horse power in the older shops; while in the new shops and foundry there is a 220-horse-power gas motor and another of 120 horse power (both of the Winterthur system) each running a triphase Rieter generator of 390 volts for force transmission. There is also in the new shops one gas motor of 50 horse power and one gas motor of 30 horse power. For the electric cranes there is another of 50 horse power running a Brown triphase generator. For illumination by electric light two gas motors of 100 horse power are available. The plant for gas making upon the Dowson system is now equal to 700 horse power, and the company finds it more economical, in the end, to obtain energy from coal by the extraction of its gas than by its combustion—4½ to 5 cubic metres of steam-blown gasogene being produced from 1 kilogramme of coal.

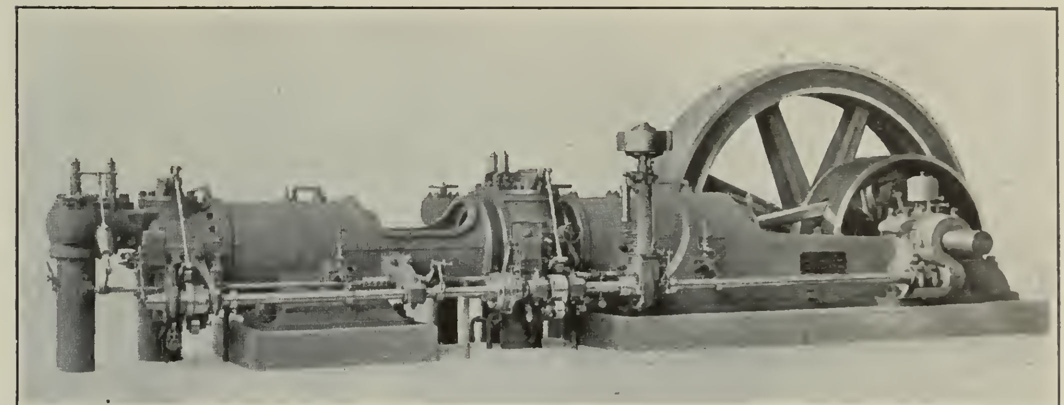
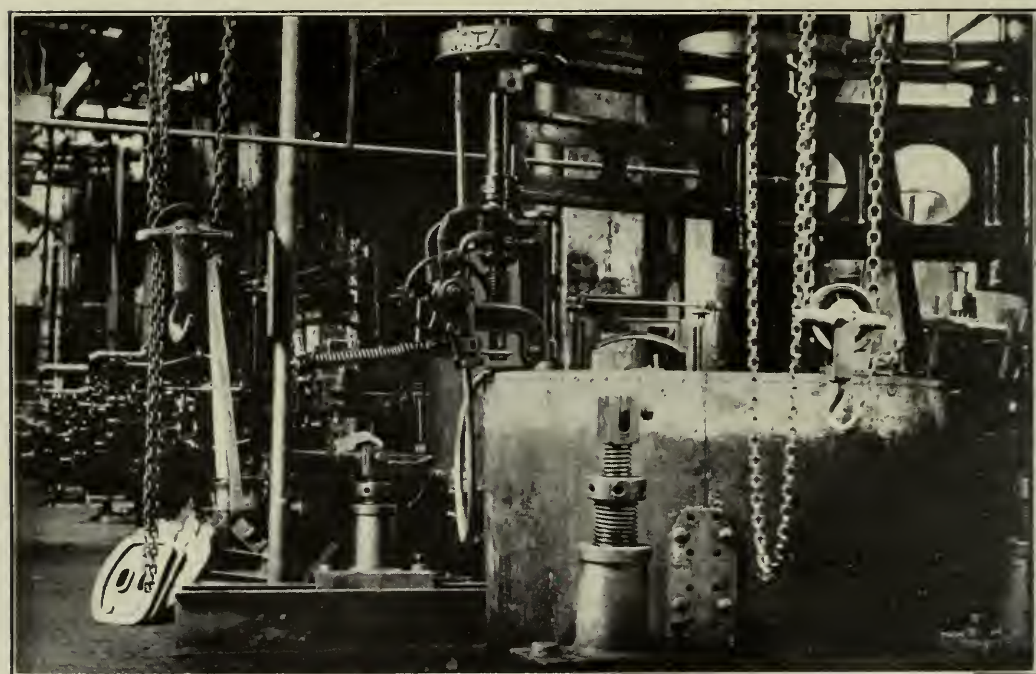


FIG. I. WINTERTHUR GAS ENGINE OF 220 HORSE POWER, DRIVING ELECTRO-GENERATOR FOR TRANSMISSION OF POWER BY TRIPHASE CURRENT TO SHOP MOTORS.

Boiler Shop.—The boilers customarily made at Winterthur often present divergencies from the usual types in the matter of the firebox casings or shells, the back plate in certain locomotives being turned round so that its flanges project outwards, the object being to enable wide-top fireboxes to be put in the shell from the back and then to rivet the boiler head entirely from the outside, instead of leaving one of the side sheets open for the insertion through the bottom side, as usual; and many of these Swiss boilers, having deep fireboxes and made for six-coupled locomotives, are given a sharp backward rake at the front of the firebox in order to allow of the axles being set as far back as possible without raising the boiler centre or cutting into the ash pan.* The flanged plates and the sheets for the boiler construction are generally obtained from Krupp's Essen works and have an

* Quite recently, October 1902, this arrangement was abandoned and the boiler axis raised very considerably, the new locomotives being for the Jura-Simplon line and ultimately destined for service on the Simplon Tunnel route to Italy.

ultimate tensile strength of from 36 to 42 kilogrammes per square millimetre and 25 per cent. elongation on a test length of 20 centimetres. With these parts for the boiler work the installation for plate working is of little importance; but, then, hydraulic flanging-presses are not common in Continental shops and in Italy some makers still do the whole of this angle work by hand in preference to making expensive dies or to paying exorbitant duties upon imported worked materials. The staying of the firebox shell and the front tube plate present no novel features, but in one locomotive boiler under construction (Norwegian) a very unusual arrangement was noticed for staying the back plate to the sides of the firebox shell in the space above the firebox crown by means of a vertical row of short palm stays. When the firebox shell is assembled it is turned on its back and its free ends are cut down level with the dot-punch line of the foundation ring by an automatic travelling milling tool of the Langbein system made by



LANGBEIN MILLING MACHINE FOR DRESSING THE EDGES OF BOILER RINGS.

the Esslingen Maschinenfabrik, Germany. In this the cutting disk is operated similarly to a small circular saw with feed motion. This tool is greatly approved at Winterthur and serves for other work besides. such as dressing boiler rings as shown by the photograph just above, made by the author at a large Italian locomotive works, the latter machine differing only in that it was made by the Esslingen Locomotive and Machine Co.'s branch works at Sarrono, Italy, and from this

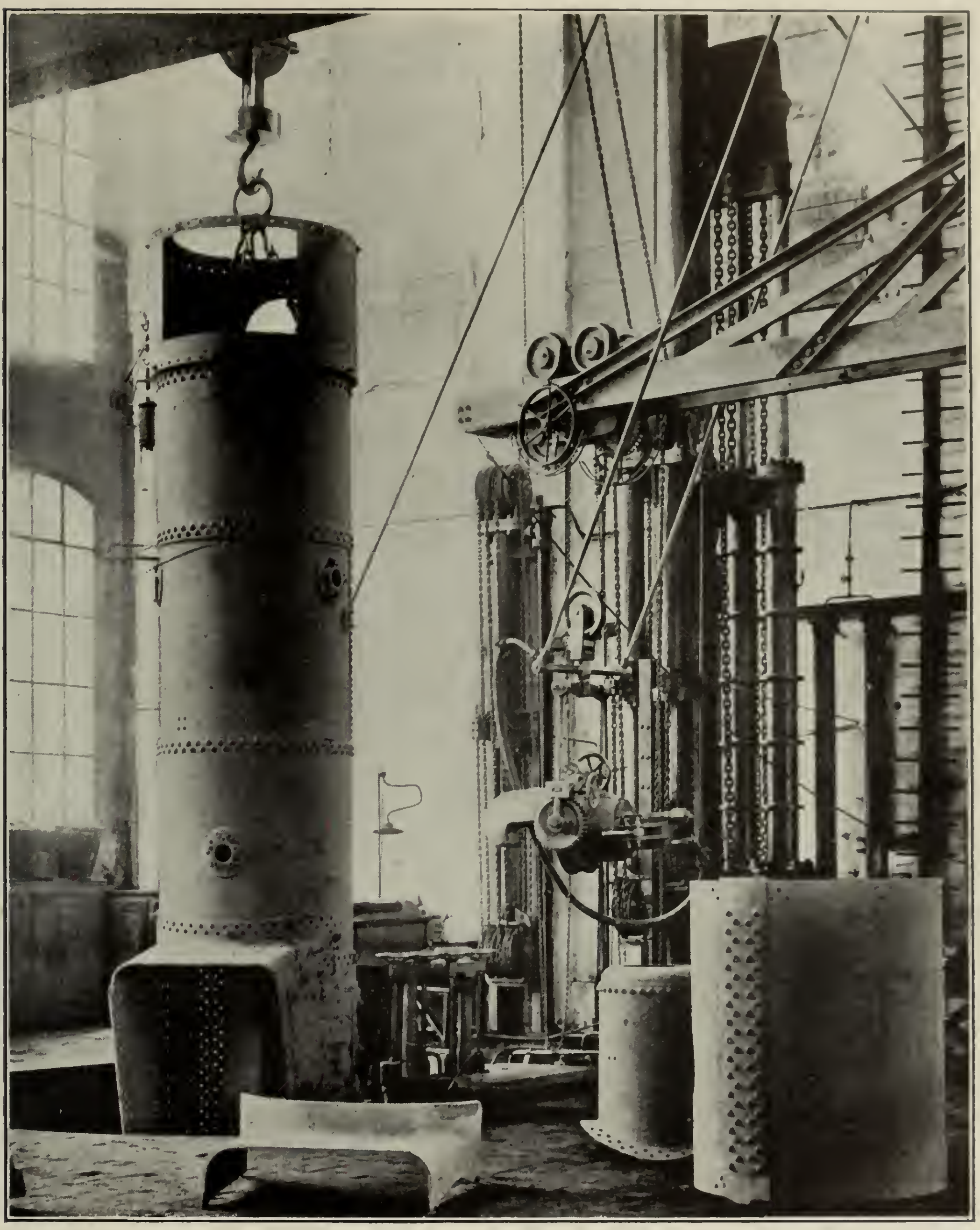
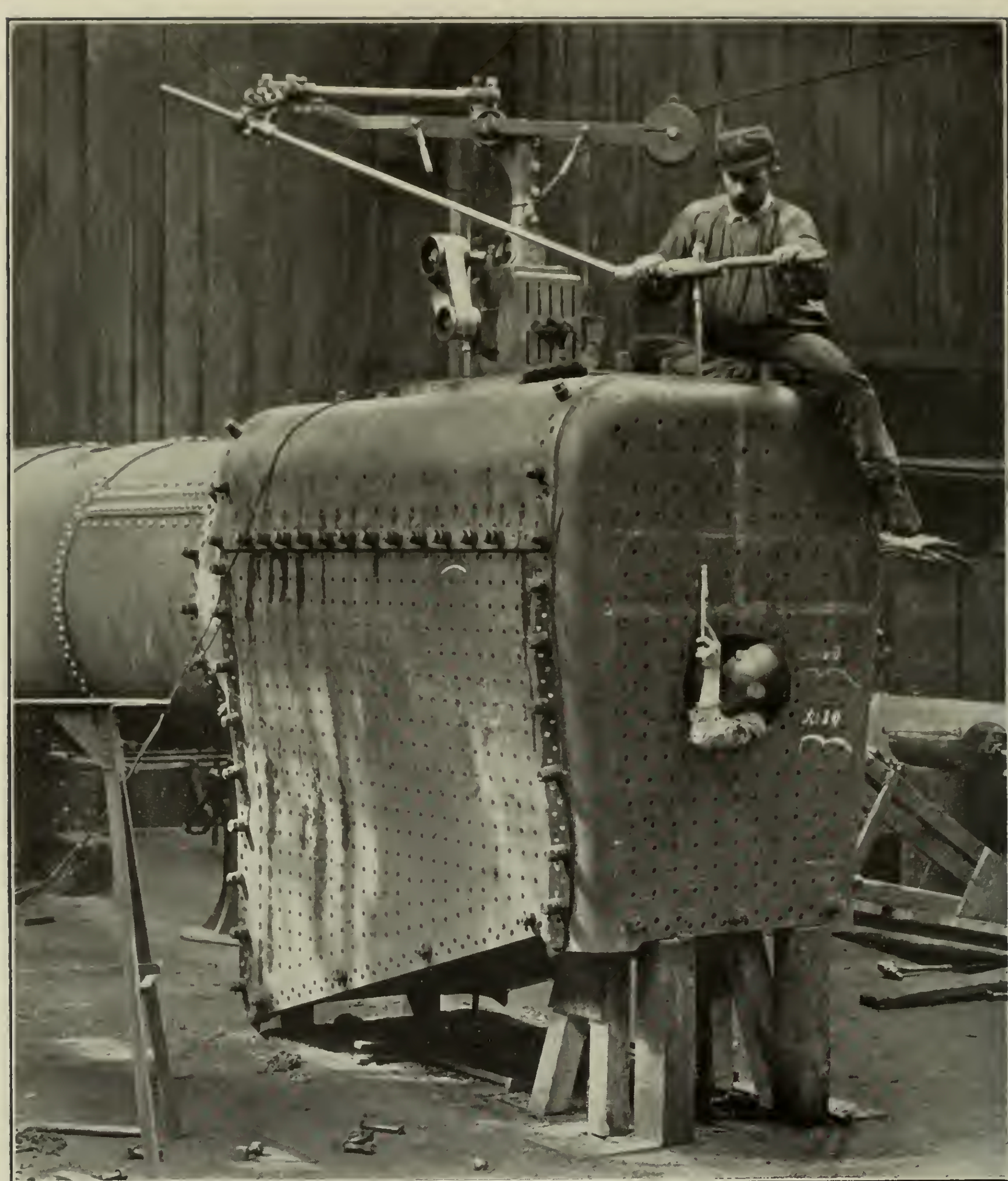


FIG. 3. HYDRAULIC RIVETTING PLANT AT THE WINTERTHUR WORKS.

view the feed and travelling motions will be understood without need of further description.

The sheets for the boiler rings are bent, the edges chamfered, holes drilled, and rivets then closed up by a hydraulic plant consisting of one large and one small rivetting machine shown in the view above, made by Brietfeld Laniek & Co. of Prag-Carolinenthal. This installation is located at one end of the boiler shop and the illustration shows the already rivetted boiler barrel assembled with a "basted" firebox

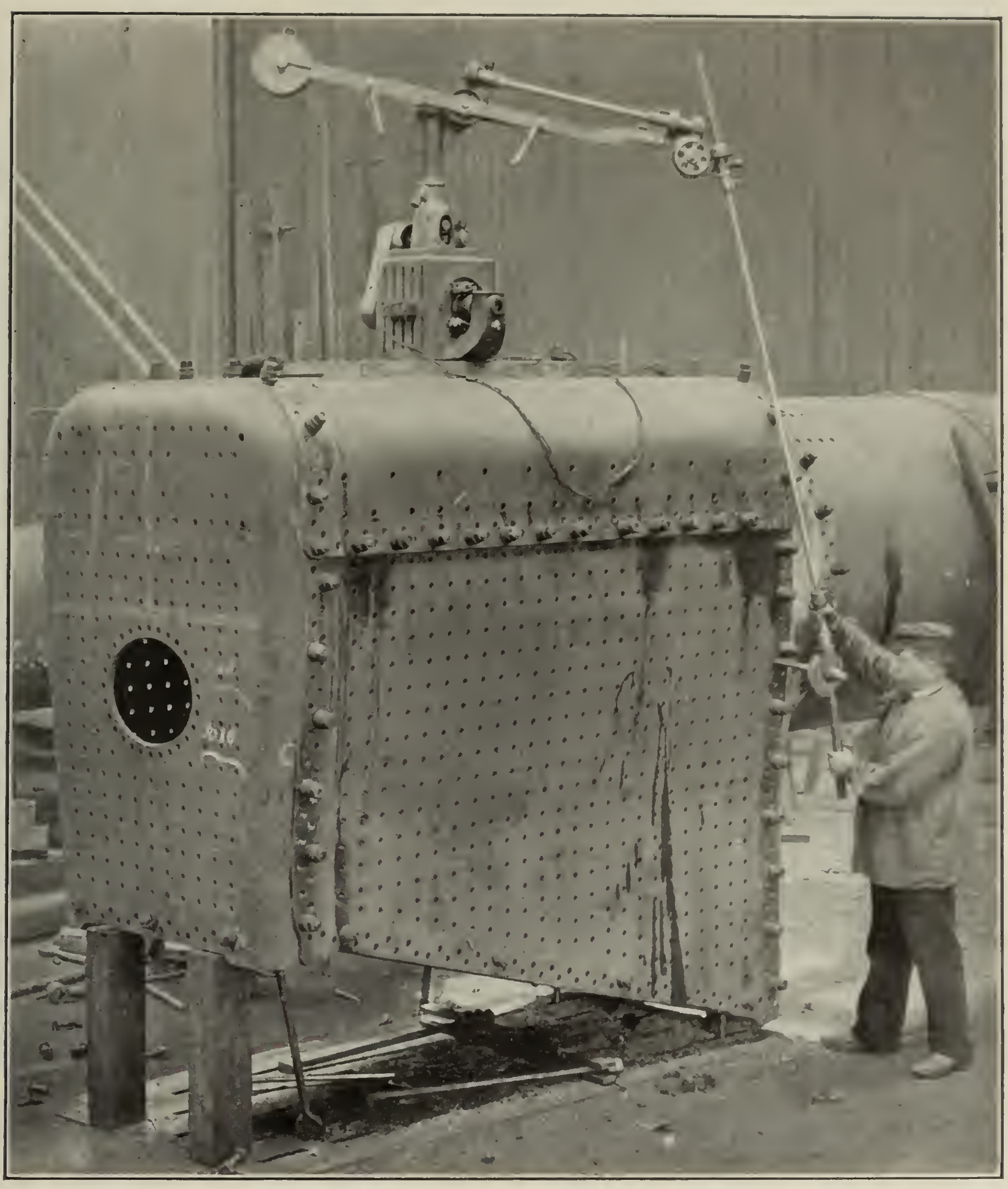


TAPPING HOLES FOR CROWN STAY BOLTS.

Courtesy of the manager of the Belfort works of the Société Alsacienne de Constructions Mécaniques.

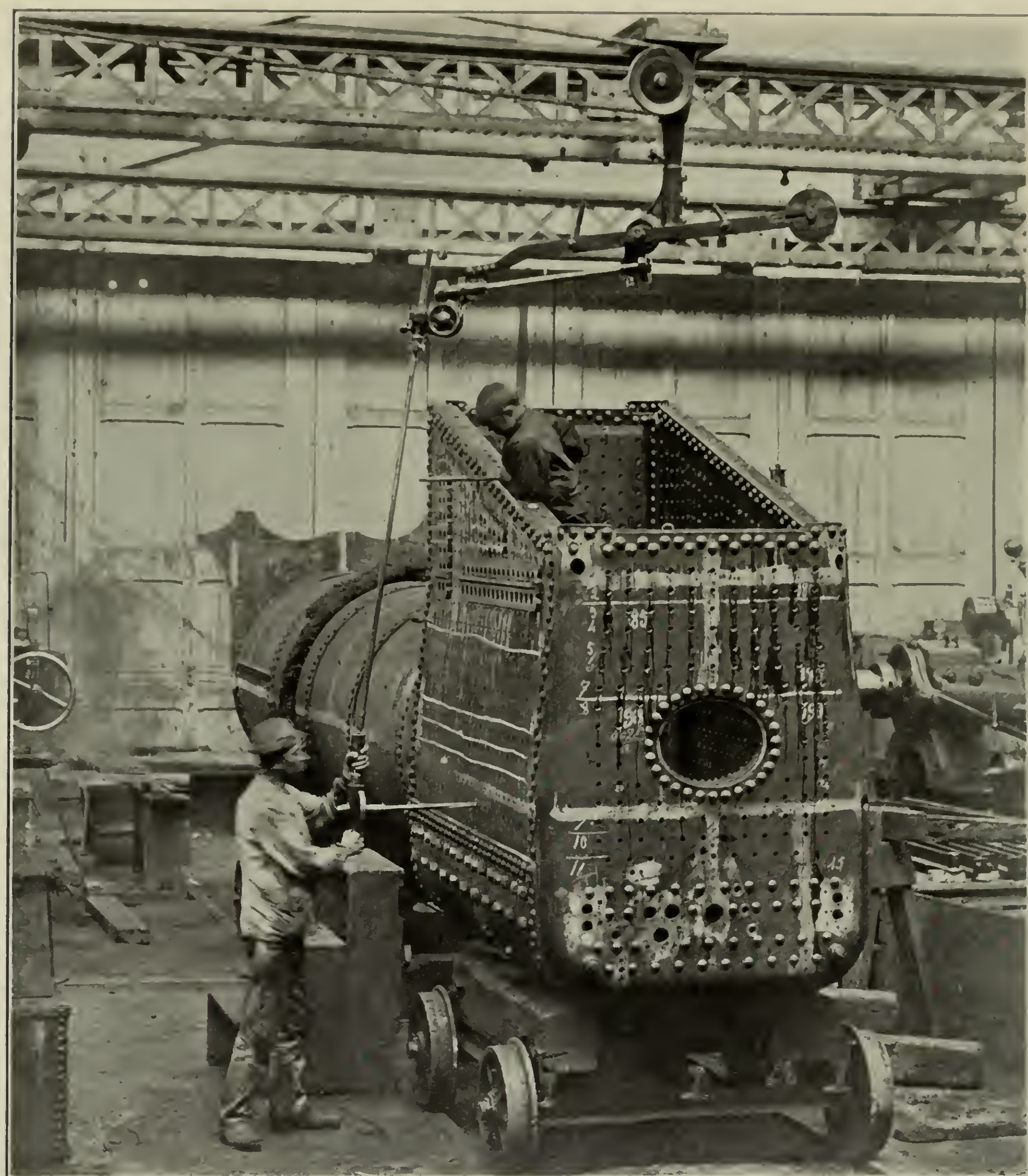
shell ready for being rivetted together. With this machine the longitudinal quadruple-rivetted seam of a ring 5 feet 10 inches long and comprising 84 rivets is finished within an hour. This work is handled over the boiler pit by a 20-ton hydraulic crane. The steam engine working the pumps of the hydraulic accumulator is of 80 horse power and the maximum water pressure is 120 atmospheres per square centimetre.

The foundation rings are completely milled on all sides by the various tools employed for this work and made by Oerlikon, Shultz



REAMING RIVET HOLES OF FIREBOX SHELL.
Courtesy of Société Alsacienne de Constructions Mécaniques.

(Mulhausen) and Kendal & Gent, and after a temporary assemblage and rivetting in place of the expansion slide-brackets, the inner box is inserted either from below through the front, or from behind, according to the type of boiler, and the final rivetting together of the two boxes is effected at the foundation-ring and firehole and followed up by the copper side-staying. The firebox stay holes are both reamed and tapped by means of a very handy universal drilling attachment run by a small electric motor called "The Belfort" and this is illustrated by the annexed photographs.



REAMING HOLES FOR COPPER SIDE STAYS.

These appliances are ordinarily attached to the casing of the motor itself for reaming and tapping crown stay holes as on page 848, and the side plate rivet holes as on page 849, or, when the boiler is turned over, and there is then no means of fixing it on the boiler itself, the swivelling arm can be affixed to any roof-girder bracket and motion then obtained by a cord drive from the same small and portable electro-motor, as shown in the illustration above.

With a current of 110 volts the force of the motor is about 3 horse power and the rate of tool speed is 125 revolutions. The inside and outside boxes can be reamed and tapped at the rate of a little under one hole in three minutes. This appliance is said by the Winterthur company to give highly satisfactory results.

Copper screwed stays differ considerably according to the locomotive specifications. After the copper bars from which they are made have been screwed they are bored, partially or completely, on a double-headed stay-drilling machine, or in other cases the holes are already formed by the Mannesmann process as practiced by the noted firm of Heckmann of Duisburg, Germany.

Very often the holes in either extremity of copper screwed stays have a depth only just sufficient to penetrate into the water space, so that if the stay breaks near up to the plates, as it generally does, its situation can at once be located. At the works it was said that the outer holes are always closed up, since, unless ferrules be rivetted between the boiler and its metal sheathing, it is not possible to locate a leaking stay exactly. This does not appear to be corroborated in German practice wherein ferrules are not often used as is regularly done in Austria; moreover, I have seen Winterthur-built engines in repair shops with the stays opened out externally, although without knowing whether this was done by the builders or by the railroad company during repairs. Where the outside extremity is closed up by the rivetting it is of course necessary only to plug the inside end in awaiting the replacement of a broken stay. Manganese screwed stays are in some cases used at Winterthur for those upper and forward rows subject to the most strain, and around the firehole. Their ends are staved up to form a round head just as it is done with copper stays, but a small plug of iron is inserted in the outside hole and this, probably, serves to preserve the head to some extent from that disaggregation due to rivetting which has been observed in certain French works, where the yellow stays are now merely flattened down, with better results for this form of metal than has been the common experience in England.

The iron crown staybolts are cut off to the exact size before being screwed home, but for the copper screwed stays this is not done, or the exact reverse of the practice followed in some Italian locomotive works. At Winterthur the projecting ends of the copper stays are nipped off by a somewhat cumbrous compressed-air tool suspended from a crane and handled by one man (said to be an imitation of an American tool). This does its work very well when there is plenty of air pressure; otherwise the jaws fail to bite off the ends with the regularity desirable in such a machine. The speed of the operation is about two per minute when the misses are not counted.

In a special shop for lagging plates and brass work the tubes are fitted with brass or copper ends, and this is effected by turning one end down to form a spigot, the other to form a socket, and between the two a brazing solder and flux is run and the joint finally dressed up. This operation is performed at the rate of twenty tubes per hour.

When the boiler is caulked and tubed, it is tested under water pressure and then run out of the shops into an open space, and there fired up for testing by steam pressure, after which it is taken to the erecting shop and dropped on to its frames ready for the steam piping and metal lagging.

General Machine Shops.—In the machine shops the best tools are the well-known machines from the Sellers, the Pond, the Cincinnati, the Bement-Miles and Ingersoll machine-tool companies, in addition to to others from Kendall and Gent, Smith & Coventry, Grafenstaden (Société Alsacienne), Chemnitz Maschinenfabrik, Oerlikon, etc. A multiple-head drill by Craven Brothers, able to bore eleven holes simultaneously, is to be noted in the equipment. A number of planers are still used where nowadays elsewhere milling tools are often employed. The best of these machines have a quick return-speed of 4 to 1, or 72 feet per minute.

Cylinders.—These are cast at the adjoining works of Gebruder Sulzer and are worked up and finally tested hydraulically by the railroad inspector. Later on, when completed, the locomotive is tested on one of the Federal lines, while narrow-gauge locomotives are tried upon a shop line of 650 yards length.

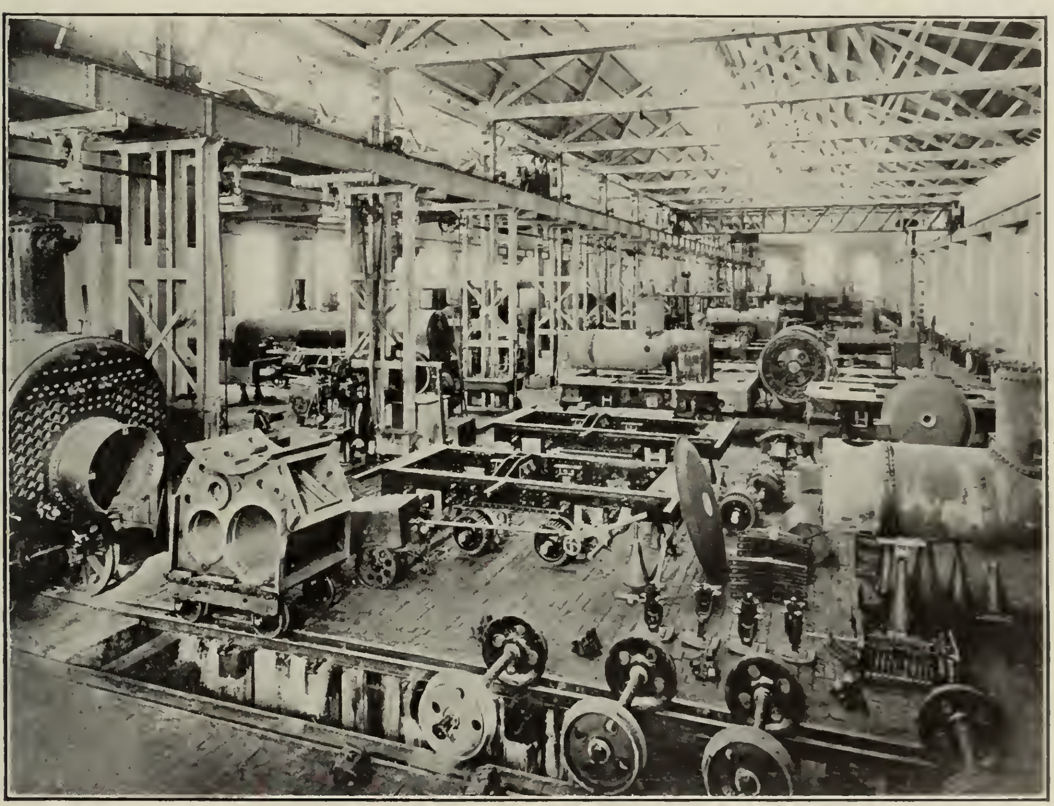
The large inside-cylinder castings are for two, three, and four-cylinder compounds. One of the first-named, for the locomotives of the Nord-Ost Bahn (now Bundesbahnen), is shown in the view of the erecting shop. Its inclined valve-seatings and the half-automatic starting-valve bore are here shown completely machined ready for the fitter. Other one-piece castings have a single inside low-pressure cylinder, and yet others have two equal-sized inside cylinders—hitherto always for high pressure, but now, quite recently, for low pressure and therefore according to French practice.* Piston rings or segments are cut from a turned and bored cylinder of cast iron, for which work vertical boring machines are always employed. Of these machines there are now in use for small work five, all of English make.

Steels for the various work are obtained variously from Germany, England, and Austria. Main driving rods, connecting side rods, and sometimes the reversing rods or weigh bars, are all channelled, and this is done by milling out in the ordinary way. The merit of the work

* The latest express engines of the Jura-Simplon Railroad.

done at Winterthur resides as much as anything in the motion details which are designed with especial care, the parts being very finely proportioned and as light as is possible, consistent with great strength.

Eyes and bushes for plain ends are ground after hardening on a grinding machine by Schmaltz of Offenback, the composition wheels having fast rotary and slow concentric movements and adjustable so that the eccentricity can be varied to suit different sized holes. The links of the valve motions, after being tempered, are ground up true on two special automatic grinding tools. Valve buckles ("cages") are one-piece forgings of Siemens-Martin steel—which is the kind of steel most often employed for the motion work. The cross-



THE ERECTING SHOP AT WINTERTHUR.

head bars, of which there is now a tendency to use only one for each cross head of outside cylinders, are said to be always hardened and ground up true after that process. There are ten grinding mills.

Frames.—After drilling the holes at the angles the frames are clamped by the half dozen to the bed of a large slotting machine and the pieces for the axle boxes or for lightening the frames are then removed. The plate frames for the Norwegian engine previously mentioned had the thickness of 1⅝ inches, which is of course very exceptional with European locomotives.

The side frames are braced together by transverse frames of steel castings. These are often of considerable length and the whole of their flanged edges, where rivetted to the side frames, are dressed upon a special milling machine made by the Oerlikon company. Were it convenient to dress by planing, grinding, or milling the inside surfaces of the side frames, the frame work of a Continental engine as now built up with so much steel castings and milled as described, would present a basis for such absolute correct jig and template work that measuring, squaring, and aligning appliances would be unnecessary for the erection of the engine and motion. At present this is not done, and at Winterthur, as elsewhere, the tight line and square have to be employed for verification.

Wheel Shop and Turnery.—In the wheel bay there are two large vertical turning machines for tires, one of American and the other of English origin. Wheel centres and axles generally come from Germany and the cranked axles are usually from Krupp's. At present the crank axles most often used are of the oblique type—that is, with only one right-angle web for each main driving-rod end. This forging is delivered entirely finished and has a very massive appearance, being of rectangular section, 10 by 12 inches, with rounded corners, and yet weighs about 550 pounds less than what may now be termed the old-fashioned straight-type crank axle. The cost of its forging is, however, higher than the latter pattern (2 to 3 per cent.). In nickel steel entirely finished it costs 4,000 francs. The webs are either circular or elliptical in form and the axles may be of neat round section, as are, for instance, those in the Italian-built express engines of the Roumanian State Railways.

When it has no inside eccentrics of the antiquated cam and strap type this form of axle is the one that is the most easily inspected and attended by engine men.

Erecting Shop.—A general idea of this shop may be had from the view page 853, from which it will be observed that steam street-car locomotives and street-railway electromotors are also assembled in this place, whence the cylinders and motion are brought direct from the machine shops; for it is necessary to say here that there is no stock magazine and work is gauged and checked on the spot. The parts are now mounted up and tested for alignment, but being all made very carefully to standard templates and gauges the accuracy of fit is generally perfect and the interchangeability of parts as certain as possible for locomotive work.

Smithy.—On account of the high price of coal all large forged work is obtained from outside firms, principally in Germany, and thus, main connecting rods and similar work being imported, the work done on the spot is of a small kind only. In the smithy there are six steam hammers, the largest being of only half a ton.

Foundry.—As the cylinders, chimneys, and other large castings are obtained from Sulzer Brothers, the foundry work is reserved for smaller pieces. It is equipped with a 9-ton crane, but the new foundry will be of more importance and have a 25-ton crane.

Model-Makers' Shop.—Models or patterns are very finely made at these works, varnished, and preserved with care in a lofty well-aired building adjoining the wood-workers' shop. This latter, of moderate size, has its saws, planers, and lathes run by a 12-horse-power engine with Winterthur patent gasogene generator working by the aspiration of the motor.

Drawing Offices.—These are located on the first floor above the general offices. The drawing offices are divided into three parts—locomotives, gas-engines, and projects; and there are 40 draughtsmen employed altogether. The light in this open part of the country is ordinarily very good, but for night work shaded incandescent lamps are employed. The system of indirect lighting (reflected from the ceiling) sometimes employed in England has not been found to be satisfactory here, so each man has his own lamps, which he can hang at any desired height or position by a number of wire hooks upon a light pivoting bracket suspended from the ceiling. The tables have cast-iron pedestals which formerly could be regulated for height—an arrangement now abandoned. In the special room for projects—a quiet room with subdued light, apart from the others—a vertical adjustable drawing board was noted, the draughtsmen sitting or standing as before an easel. The square or straightedge for base lines is hung upon cords passing over pulleys in connection with a counterweight, and a grooved ledge in the straightedge contains drawing tools, set squares, and ink, so that all lines should be geometrically accurate without special effort on the part of the draughtsman. The board can be inclined at any angle and there are drawers attached to the pedestal for papers etc. The makers are Billweller & Kradolfer of Zürich and Siegrist of Schaffhouse. Despite its obvious advantages it appears that the young men prefer to lie across a table and perhaps lay up a case of appendicitis, rather than accept the offer of such a board.

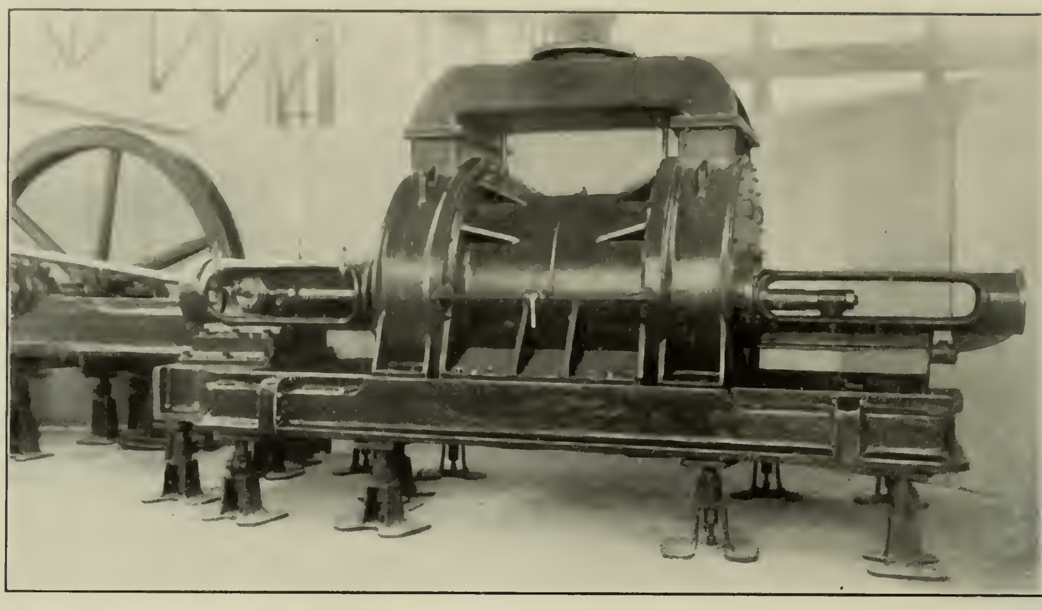


FIG. 16. EHRHARDT & SEHMER MINE PUMP.

ELECTRIC POWER APPLIANCES IN THE MINES OF EUROPE.

By Emile Guarini.

In a preceding article M. Guarini took up a general review of Continental practice in the secondary operations of signalling and lighting. The present paper deals with the more direct applications of electricity to the work of ore getting and ore handling.—THE EDITORS.

THE primary applications of electricity to power purposes in European mining practice fall into four groups. First stand the uses directed to the safety of the mine and the mine workers; these are for the operation of the pumping and ventilating machinery. Second come the direct applications to ore getting, including the driving of drills and mining machines, and the electric firing of shots. The third group comprises the applications to the transport of the ore and includes locomotives and tramming, hauling, and hoisting machinery. Finally, the fourth group of applications are those concerned in the treatment of the ore after extraction—in stamp mills, crushers, screens, etc.

The direct operation of mine-drainage pumps is one of the most troublesome problems the electrical engineer has had to solve, on account of the very high speed of the electric motor and the very slow speed of the mine pump. Builders of motors and of pumps have approached each other by a series of concessions, the former slowing down and the latter speeding up their respective machines. From this has resulted the so-called "express pumps" made by many firms—among other builders on the Continent, by Ehrhardt & Sehmer, the Maschinenbau Anstalt of Breslau, Riedler & Stumpf, Hope of Berlin, and Jaudin of Lyons. The pumps of Ehrhardt & Sehmer are specialised by their mechanical construction, of which Figure 16 gives a general idea. The plungers are single-acting, the valves vertical-lift and superposed. The valve seats are held by lateral studs; the plungers are worked directly by the rod. The volumetric efficiency is 94 to 96 per cent. The pumps are built single, duplex, and triple. A notable example is the triple pump of this make installed at the Marlesen collieries in 1902. The required duty was 4,200 to 4,300 litres per minute at 160 revolutions. The stroke of the plungers is 315 millimetres, their diameter 194 millimetres, their area 2.956 square decimetres (45.8 square inches), and the discharge volume for a single revolution 27.94 litres; the actual efficiency is 4,500 to 4,600 litres per minute at 171 revolutions, with a lift of 268 metres. The efficiency of the electric motor is 96 per cent; the mean volumetric efficiency of the pump is 95 to 96 per cent; the mechanical efficiency is 83 per cent, and the total efficiency 64 per cent. In another installation with a triphase motor at 2,400 volts the total efficiency is 68.6 per cent.

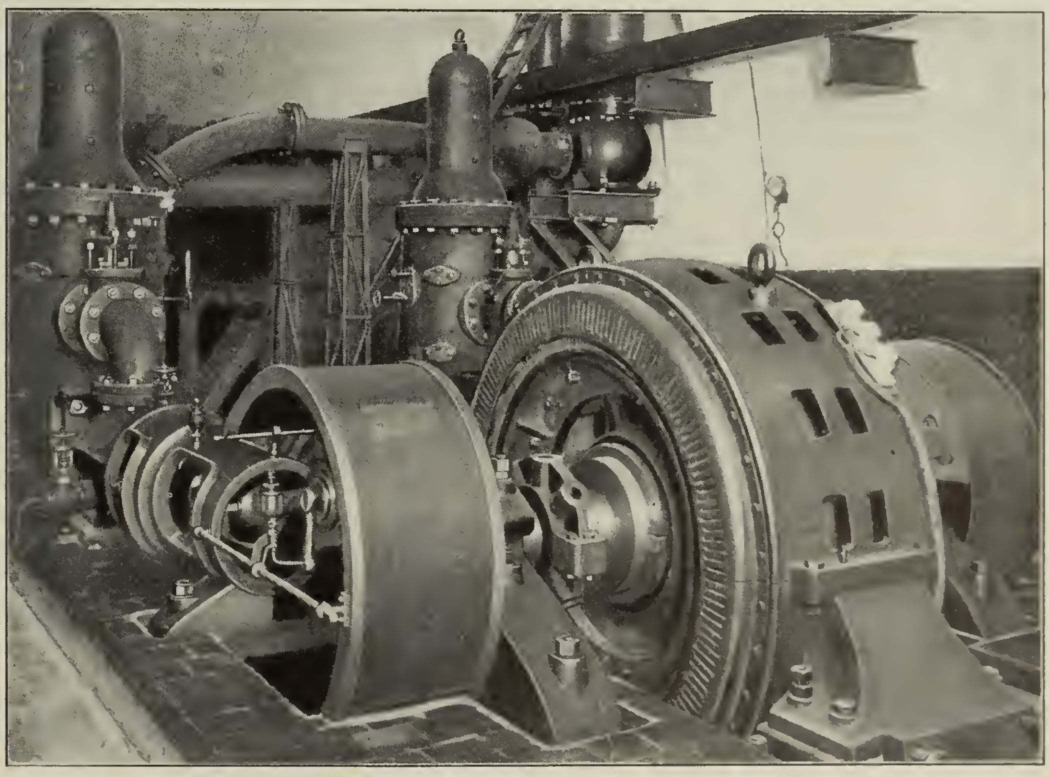


FIG. 17. ELECTRIC-DRIVEN PUMPING PLANT, GELSENKIRCHEN MINING COMPANY.

Figure 17 shows the electric-driven pumping plant of the "Germania I" shaft of the Gelsenkirchen mining company. This installation, put in by the Helios Company, operates a duplex pump by Bergman of Breslau, of a capacity of 3 cubic metres per second at a velocity of 180 revolutions and a lift of 160 metres. The direct-coupled polyphase Helios motor develops 160 horse power at 2,200 volts.

The Riedler-Stumpf pump is characterised by having the suction valve concentric with the plunger and also by its speed, rising to 300 revolutions. The first electrically equipped Riedler pumps were installed at Leopoldshall in 1899. Later installations have been made at the Aumetz-Friede, Kübeck, Engelsburg, and other shafts. In the cases last named the pumps run at 200 revolutions; their capacity is 2.5 cubic metres per minute with a lift of 570 metres. They are driven by triphase motors made by the Allgemeine Elektricitäts Gesellschaft, taking current at 2,300 volts and 110 periods per second.

The Jaudin pump, like the preceding, permits speeds of 300 revolutions. A Jaudin pump installed by the Oerlikon Company at the Monterrad shaft at Firminy has a capacity of 2.7 cubic metres at 100 revolutions with a lift of 285.5 metres. It is direct-coupled to a 200-horse-power triphase Oerlikon motor making 100 revolutions and taking current at 970 volts and 20 periods.

The Oerlikon Company, however, prefer pumps of moderate speed to the express type, on account of the rapid wear of the latter. In this view they installed, at the Kaiserstuhl II shaft at Dortmund, a Hoppe pump of 5 cubic metres' capacity at 75 revolutions with a lift of 400 metres, direct-driven by a triphase asynchronous motor of 570 horse power. The English companies also seem to prefer slow-speed pumps; the Westinghouse Company, for example, supplied to the Sneyd colliery a pump driven by a 30-horse-power triphase motor for a duty of 62 gallons lifted 780 feet, and to the Oak Bank Oil Company, centrifugal pumps direct-coupled to three triphase motors of 5 horse power each for pumping 4,000 gallons per hour to a height of 40 feet.

In the case of small pumps the coupling with electric motors presents no difficulties; the energies of the Siemens & Halske, Schückert, Union, and other companies referred to have therefore been directed toward large pumping plant. Their perseverance is explained and warranted by the great superiority of electricity as a motive power in this connection. The first cost, as compared with that of steam plant, it is true is somewhat higher; but the daily running expense is less, the energy losses are lower, the wear and tear of generating machinery and driving motors are very small, and finally electricity is without the objection of impairing the ventilation of the mine and affecting injuriously the timbering, both of which defects apply in the case of the use of steam with its necessary piping.

Ventilation is almost as important as pumping to the safety of the mine, and the electric operation of ventilating machinery does not offer the same difficulties. It is effected by direct coupling, by belts, and by

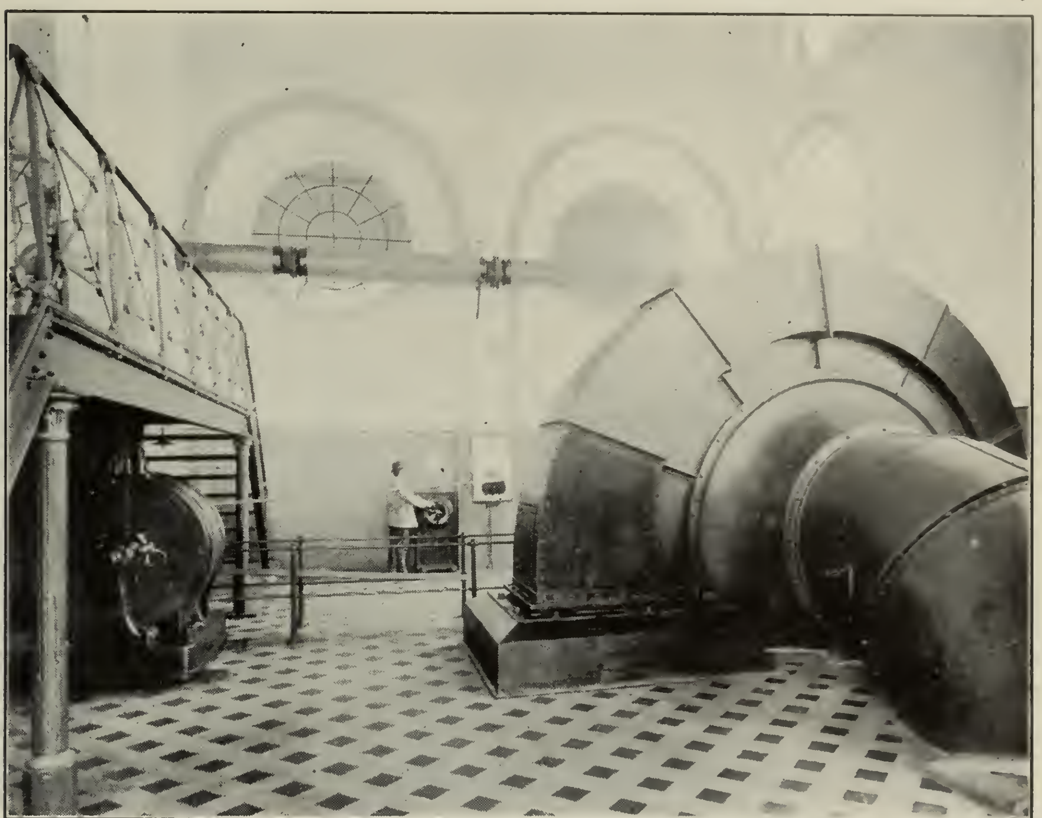


FIG. 18. VENTILATING FAN OF THE GLÜCKAUF MINE, SONDERSHAUSEN.

flexible shafting. Mine ventilators are of two sorts—those placed in the levels or other parts of the workings for local ventilation, and the large ventilating fans at the head works. These latter may be regulated either through the mechanical power transmission, by the alteration of the area of the air intake, or, when driven by direct-current motor, by changing the speed.

Figure 18 shows the ventilating fan of the Glückauf mine at Sondershausen. It is belt-driven in order to facilitate speed changes. The motor (of Siemens & Halske manufacture) is of 100 horse power and 500 volts. Although the fan is in the immediate neighbourhood of the steam plant, electric driving is preferred on account of the saving in labour of oversight which it permits.

Almost all the electric companies mentioned heretofore in these articles have done more or less important work in the way of electric ventilating plant for mines. To mention a few instances only there is the installation of the Germania II shaft (Helios) with a 2,000-volt polyphase motor of 400 horse power; that of the Hollertzug mine, put in by the Allgemeine Elektricitäts Gesellschaft; that of the Karwin mines, by Siemens & Halske, etc. All these examples agree in supporting the claims for the economy, simplicity, and convenience of the electrical system.

Electric operation of drills is the most important application to the direct processes of ore getting, but it has to make its way against a most powerful competitor—compressed air. The advantages of the latter for percussion drills are indeed such that the Schückert Company have retained it to the full as the actual operative agency, merely doing away with the disadvantages due to the use of piping. With this aim they have designed the apparatus shown in Figure 19—an air compressor driven by an electric motor with a compressed-air reservoir, all arranged to run on rails and to be thus moved to the ore breast. By this means the inconvenience of long air mains is avoided, the power being brought close to the point of actual application in the

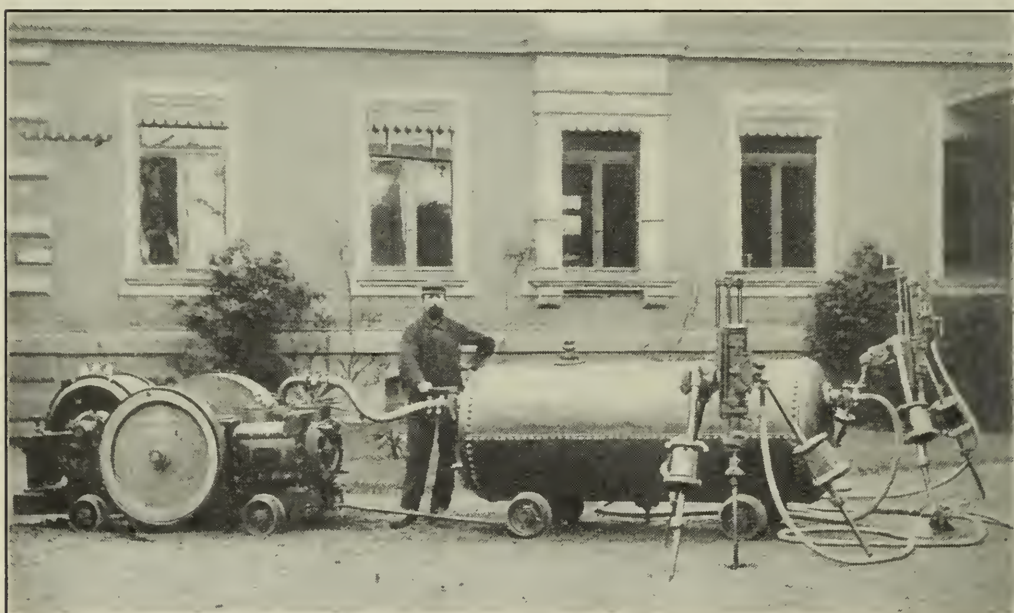


FIG. 19. ELECTRIC-DRIVEN AIR COMPRESSOR FOR MINING DRILL OUTFIT.

form of electric current, by the more convenient electric cables. In this respect, however, Schückert practice differs from that of other companies, which have designed drills driven altogether by electricity.

Rotary drills work well in soft rock, but for hard rock the percussion type is preferable. Electric driving of rotary drills presents no difficulty; it is effected either by direct coupling of the motor to the

FIG. 20. ROTARY MINE DRILL ELECTRIC-DRIVEN THROUGH FLEXIBLE SHAFT.

drill, as in the practice of the Union Elektricitäts Gesellschaft, the boring bit being driven through gearing by a 2-horse-power motor—or (the practice just described not having met with general adoption by other companies) the transmission may be by flexible shaft as shown in Figure 20, which represents a rotary drill installed by the Siemens & Halske Company in the Charles-Ferdinand drift at Gross-Hettingen. Percussion drills, on the contrary, are not at all so easily adapted to electric driving. The many efforts made have resulted in three principal systems—the solenoid, the cam, and the Siemens & Halske crank.

In the solenoid system there is a coil divided into two sections and surrounding an iron core. Current is sent through the sections alternately, and the core alternately attracted in opposite directions. The drill bit is in direct connection with the core and receives the necessary turning movement from a pawl actuated by the reciprocating movement of the core. This drill has the advantage or requiring no motor; it has the defects of low power and of heating.

In the second system the drill is driven by a cam fixed on a shaft revolving at 300 to 350 revolutions; the cam engages a small wheel on the breech of the percussion drill and drives it backward, compressing a spring which gives the forward blow as soon as the cam releases the disk. The objections offered to this system are that it does

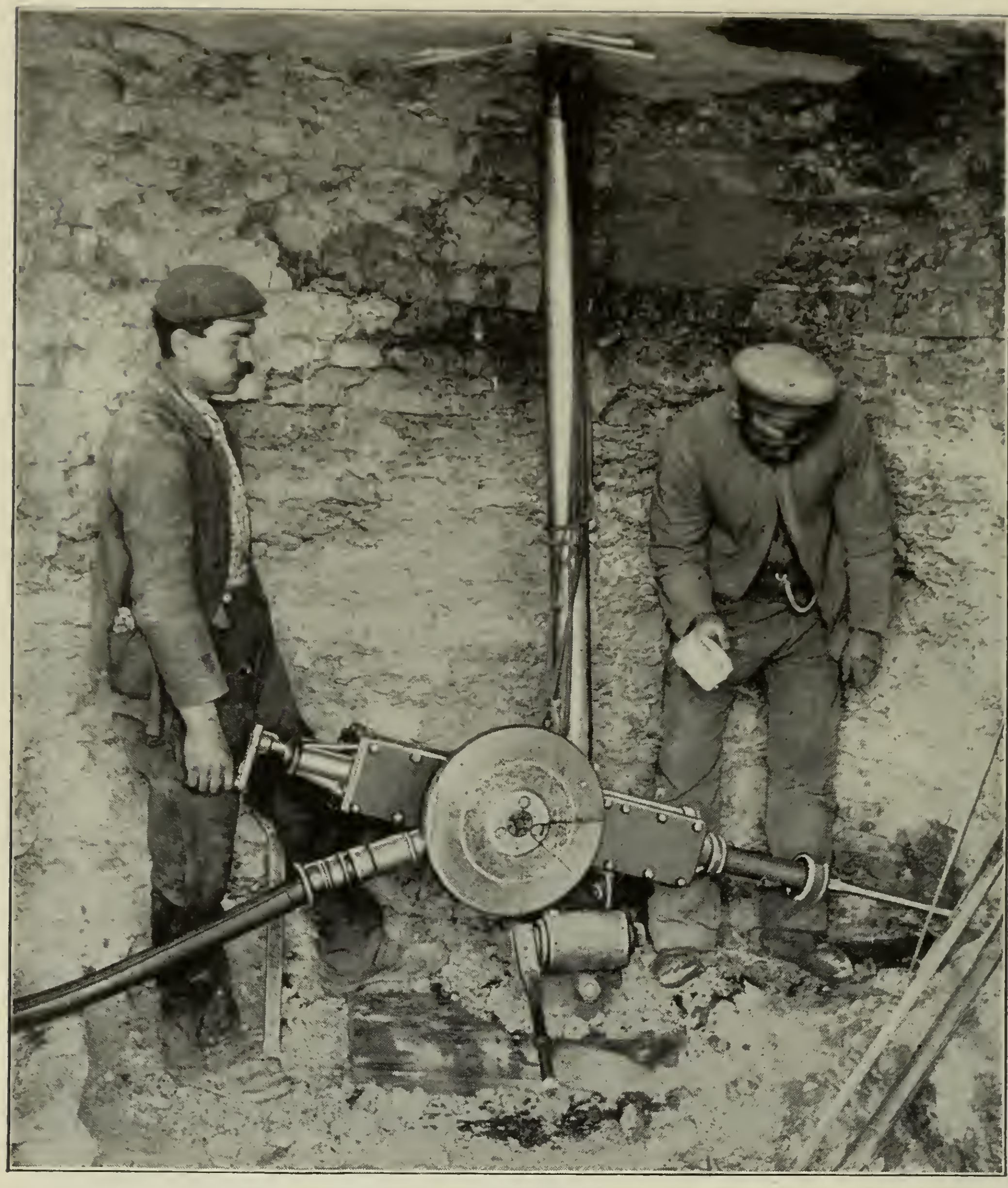


FIG. 21. ELECTRIC MINING DRILL, PERCUSSION TYPE, CRANK SYSTEM.

not work as well overhead as downward, and that it requires close synchronism between the movement of the cam and that of the breech.

The crank system employs a crank shaft which, by a small bronze slide block working on a steel slide, imparts a reciprocating motion to a carriage. Two strong spiral springs are set between the end plates of the carriage, and between these is the "percussion box" inside which is the breechblock of the drill; this is free to move inside the springs and transversely to the end plates of the carriage. Figure 21 illustrates this drill for which the makers claim the following advantages: regular and equal force of the drill blow in any position of working; absence of shock to the mechanism; and high power and high speed (420 to 450 strokes per minute). It is objected to, on the other hand, on account of its complicated construction, its liability to derangement, its rapid wear, and the frequent and large expenses resulting therefrom.

A Schückert drill of mixed type, in the Friedrich Wilhelm mine, working in hard sandstone and hematite, advanced the gallery 24.8 metres in 248 hours. Cam drills of the Electricité et Hydraulique company's make, in a trial of four or five months in the Courcelles colliery, showed a gain in drifting of .80 metres by machine as against .40 metres by hand drilling in equal time, with a cost of 60 francs a metre for the machine work as against 103 metres with hand drilling. Lastly the cam drill in the Kotterbach mine in Hungary, working in moderately hard spathic iron ore, showed a record of 12.5 metres drilled in 9 hours. The rate of actual boring was from 5.5 to 6 centimetres a minute.

In addition to mining drills, coal-cutting machines are used to advantage in colliery working, notably the Sullivan system exploited by the Union Elektricitäts Gesellschaft. This machine, of American origin, consists essentially of a chain carrying cutters and carried around two pulleys driven by an electric motor.

Electric firing is accomplished in two ways—by the electric spark and by the incandescent platinum wire. The latter is usually preferred on account of its greater certainty. Magneto machines are used when the number of shots to be fired is small, but when this rises to 80 or over a dynamo current is employed. In the Siemens & Halske magneto-electric firing key, an arrangement prevents the closing of the circuit before the induced current has reached its full value. The premature firing of the more sensitive fuses is thereby avoided. In the dynamo exploder made by the same company the induced current is controlled by a spring which is raised. When the electromotive force reaches the maximum the circuit is closed automatically, thus insuring the simultaneous explosion of all the shots.

For carrying the ore from the breast of the stope to the adit or level, small motor-drawn trucks are used. The speed is ordinarily from 1 to 1.5 metres per second with a 5 to 10-horse-power motor and a grade of 10 to 15 degrees. Figure 22 shows one of these motors for an incline in the mines of the Kaliwerke Aschersleben, installed by Siemens & Halske. It draws the cars from the working face to the main haulage road of the mine.

Where the level is straight, the haulage distance not too long, and the traffic regular, endless-rope haulage is often employed. In this case the speed of the hauling rope does not generally exceed one metre per second, so as to permit trams to be attached or detached without stoppage; the track is also double. A commutator permits the motion to be reversed in case of derailment. Figure 23 shows the haulage plant installed by the Westinghouse Company at the Sneyd colliery, Staffordshire. Electric rope haulage has found wide application in mining work, and all the larger companies have put in important installations. The mines of Planitz, Gottessegen, Rhenania, Lyden-

FIG. 22. HAULAGE BY ELECTRIC MOTOR, MINES OF THE KALIWERKE ASCHERSLEBEN.

burg (South Africa), Shimoyamada (Japan) etc. have Siemens & Halske equipment; Schückert installed the plant at the Zwickauer Steinkohlenbau Vereins, the Altgemeinde Bockwa, etc.; Gans furnished electric haulage machinery for the mines of Kivald, Tokod, Resicza, Nagy-Manyok, and many other workings.

When rope haulage is not feasible, on account of the great length or the crookedness of the levels, electric locomotives are sometimes used to haul the trams either to the open, as in the Hollertzug mine, or to the shaft. Electric locomotives are employed also for moving the ore to or from the concentration works or the stockpile. For surface transport use is made also of electric telpherage, as shown in the installation by the Union Elektricitäts Gesellschaft illustrated in Figure 24. For locomotives the direct current is usually preferred to the alternating, because it necessitates but one or two conductors and so encumbers the mine openings less.

The regular mine locomotive made by the Union is 260 centimetres long, 108 centimetres in breadth; the wheel base is 72 centimetres, and the diameter of the wheels 50 centimetres. The maximum elevation of the trolley wire is 140 centimetres. The locomotives for the surface work are of larger dimensions and take current by an aluminium roller which does not have to be reversed, like the trolleys, in case of a reversal in the direction of running.

At the Hollertzug mine, already referred to, the Allgemeine Elektricitäts Gesellschaft has furnished one locomotive for underground and another for the surface workings. The former is equipped with a geared motor of 10 to 15 horse power, starting being regulated by means of resistances. This locomotive pulls a train of twenty waggons of a total weight of 1,400 kilogrammes each at a speed of 1,800

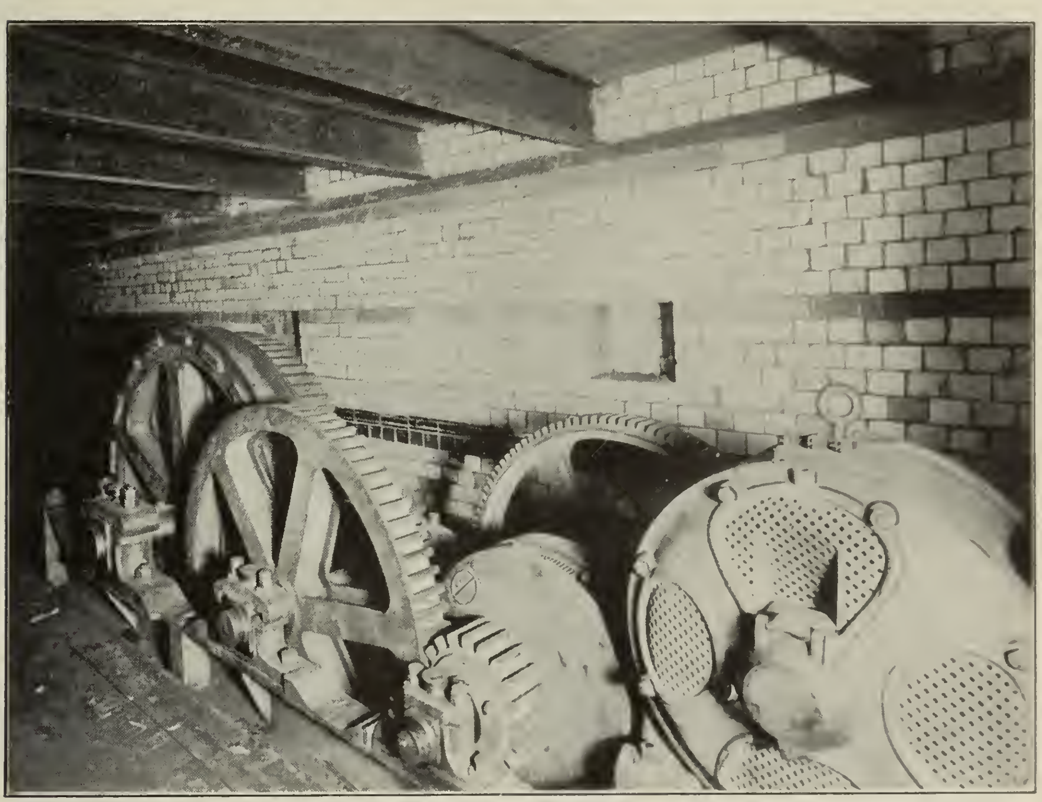


FIG. 23. ELECTRIC HAULAGE PLANT, SNEYD COLLIERY, STAFFORDSHIRE.

metres in 10 minutes—about 6¾ miles an hour. The surface locomotive is equipped with a 25-horse-power motor and hauls six loaded waggons 725 metres in 4½ minutes with a consumption of 3.7 kilowatts.

The Siemens & Halske locomotives have a speed of 10 to 15 kilometres an hour. The starting and speed-regulating resistances are placed under the frame carrying the couplers. Figure 25 shows an electric mine locomotive of this make at the rock-salt mines of Neustassfürt, near Stassfürt, Germany. The Baldwin-Westinghouse locomotives supplied to the Oak Bank Oil Co. pull a load of 85 tons at a speed of 10 miles an hour. The alternating-current locomotives furnished by Ganz to the iron mines of Vajda-Hunyad exert a tractive effort of 600 pounds; their speed is 7½ miles and their weight 3.4 tons.

Less progress is to be noted, however, in the adaptation of electric driving to the operation of mine hoisting engines, on account of the difficulties presented by this particular work. These lie in the coupling of the motor to the winding drum and in the regulation of the speed. Direct coupling requires that the speed of the motor and the diameter of the drum shall both be reduced. Speed regulation is effected in various ways. With direct current, use may be made, for example, of two motors, each of half the requisite power. Connection in series or in

FIG. 24. ELECTRIC TELPHERAGE FOR SURFACE TRANSPORT AT A MINE.

FIG. 25. ELECTRIC MINE LOCOMOTIVE, NEUSTASSFÜRT ROCK-SALT MINES.

parallel gives half or full speed. The Allgemeine Elektricitäts Gesellschaft make use of a liquid rheostat, the liquid reaching an overflow when the motor attains its full speed. Starting, speed regulation, and stopping have also been controlled by varying the excitation of the dynamo. Finally, resistances have been employed to the same effect, though not to very good advantage. Constructors have therefore given much attention to safety appliances, and hoisting machinery is generally well equipped with many safeguards—powerful brakes operated by hand, by foot, by compressed air, or automatically if the cage passes the upper landing. The automatic brake acts by cutting off the current. Another automatic device, on the other hand, comes into play if, for any cause, the circuit is unintentionally broken. In such case a powerful electromagnet is demagnetized and lets fall a weight which operates the brake.

Direct connection of the motor and the drum is hardly ever adopted except in large installations. In small ones the connection is by gearing. Figure 26 illustrates an underground hoisting equipment operated by an open type Helios motor. At the Germania I shaft this company put in an electric hoist capable of lifting a net load of 1,800 kilo-

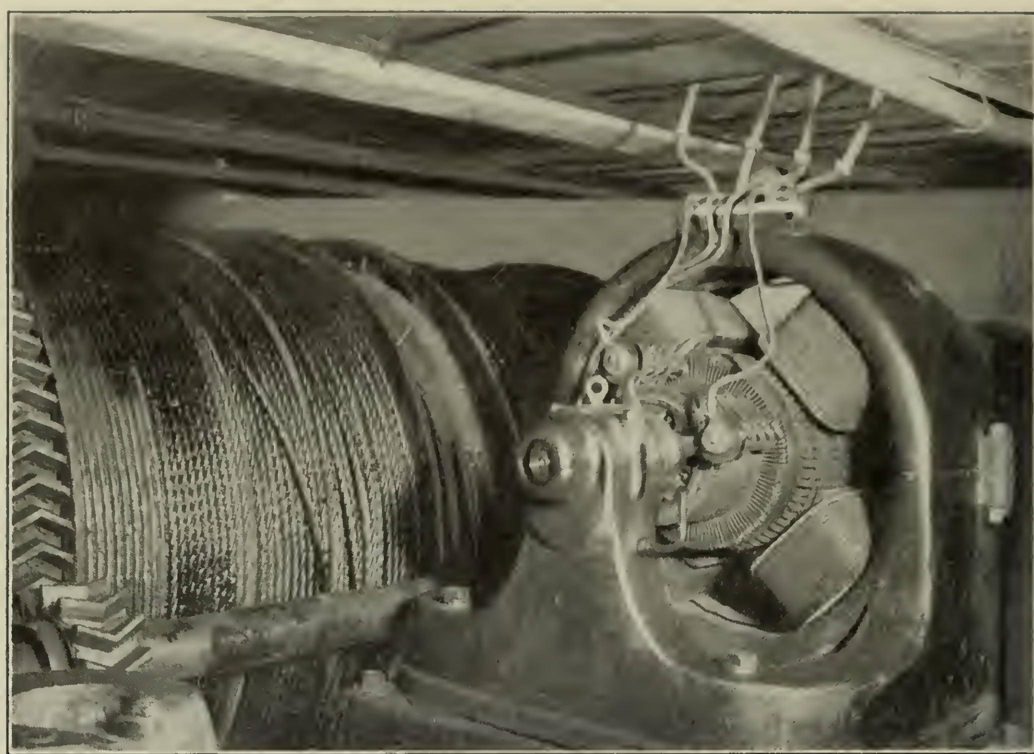


FIG. 26. UNDERGROUND HOISTING EQUIPMENT WITH OPEN TYPE MOTOR.

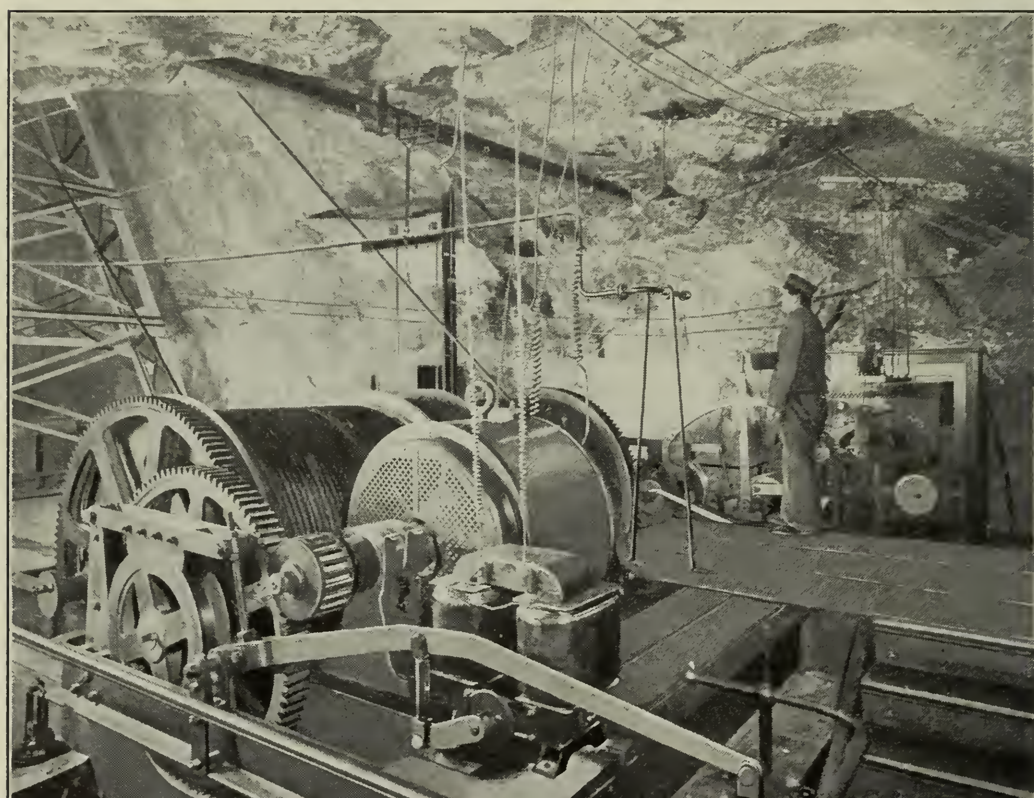


FIG. 28. ELECTRIC HOISTING PLANT, CONSOLIDIERTE ALKALIWERKE WESTEREGELN.

grammes from a depth of 450 metres at a speed of 3 metres a second; it is operated by an asynchronous polyphase motor of 120 horse power at 485 revolutions and 2,000 volts. The Rhein-Elbe installation is also noteworthy.

The main hoisting plant shown in Figure 27 is constructed by the Union Elektricitäts Gesellschaft. It is driven by two motors of 90 horse power at 500 volts. The hoisting speed is 2 metres per second with passengers and 4.2 metres per second with ore buckets, the depth being 220 metres and the net load 600 kilogrammes. The drums are 3 metres in diameter, and are driven by gearing. Another example of driving by gears is found in a hoisting plant installed in a fiery mine in Belgium by the Société Electricité et Hydraulique. The

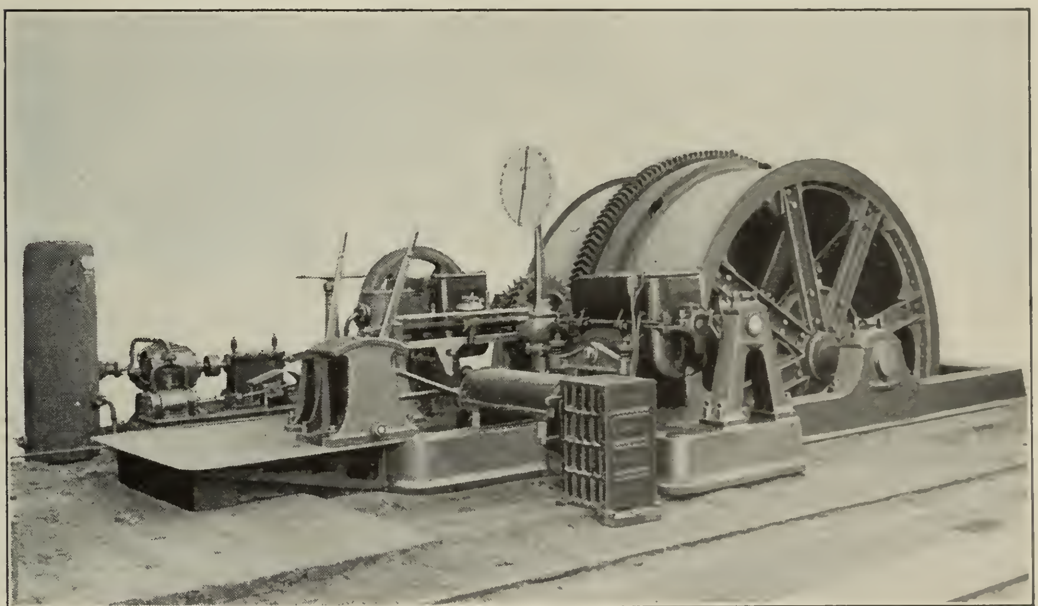


FIG. 27. MAIN HOISTING PLANT, ELECTRIC-DRIVEN BY GEARED MOTORS.

motor—of enclosed type, for 500-volt triphase current—is of 50 horse power with an overload capacity of 80 horse power, 600 revolutions; the net load is 2,000 kilogrammes which is hoisted from a depth of 100 metres at a speed of 1.5 metres per second.

The Schückert hoist exhibited at Düsseldorf had a special device for speed regulation by means of a counter electromotive force. The contra-tension was gradually reduced, allowing the motor to come up to speed. This machine was designed to take a working load of 1,400 kilogrammes from a depth of 400 metres at a speed of 15 metres a second. The three drums were each 2.5 metres in diameter. Important installations have been made also by Siemens & Halske at the Hohenegg shaft of the Karwin mines, at Erzherzog, Thiederhall, and at the

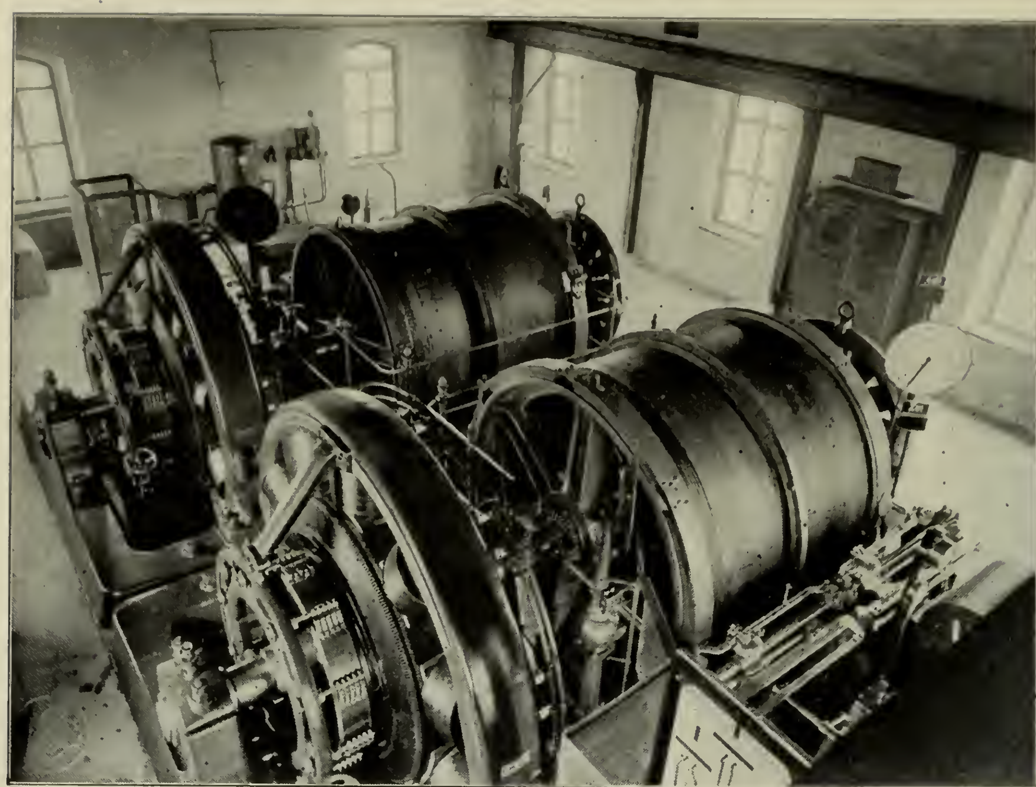


FIG. 29. ELECTRIC WINDING PLANT, ARNIM COLLIERY, NEAR PLANITZ.

Consolidierte Alkaliwerke Westeregeln. Figure 28 represents this last-named installation. The motor is of 60 horse power at 500 volts. The Hohenegg hoist is driven by a 170-horse-power triphase motor at 150 revolutions. The maximum load is 1,400 kilogrammes and the speed 4 metres per second from a depth of 260 metres. At the Erzherzog shaft a geared motor making 150 revolutions lifts a load of 2,800 kilogrammes at a speed of 4.5 metres a second. The Thiederhall hoist handles a duty of 200 tons (metric) in 8 hours; the depth is 200 metres, and a 500-volt motor, direct-connected, handles the load of 800 kilogrammes at a speed of 6 metres per second. For hoisting persons this speed is reduced to 3 metres per second.

Direct connection is employed also in the plant put in by the Allgemeine Elektricitäts Gesellschaft for the Preussen II collieries at Dortmund and the Arnim coal mines near Planitz. The former is designed to hoist 100 tons an hour from a depth of 700 metres. 2,200 kilogrammes is the net load, the weight of the cage being 3,800 kilogrammes, that of the four waggons 1,400 kilogrammes, and that of the cable 4,900 kilogrammes, a total of 12,300 kilogrammes. The speed is 16 metres a second, but this may be reduced to 5 metres. The motor is for triphase current of 2,000 volts with liquid rheostat for regulating the starting. There is a safety brake operated by compressed air, and an automatic brake operating the safety switch.

The Planitz installation is shown in Figure 29; it differs from the one just described in that it is for continuous current, at 500 volts, the motors making 80 revolutions. It raises from 600 to 700 tons from a depth of 220 metres in 10 hours. The winding drum is directly over the shaft. 600 kilogrammes of coal and 1,000 kilogrammes of waste constitute the working load, the cage weighing 700 kilogrammes, the waggons 275 kilogrammes, and the cable 345 kilogrammes. The hoisting speed is 8.5 metres a second, reducible to 3 metres. Each drum is driven by a 225-horse-power motor and is 224 centimetres in diameter by 85 centimetres in width.

While the use of electric power in mine hoisting is not yet very common, it will not fail to extend rapidly now that the necessary standard of success has been attained. It is stated, indeed, that at the Heinrichschacht shaft the adoption of electric hoisting effected an economy of 1/3 in the fuel alone, to take no account of the saving in wear and tear or in lubricants. Further, the adoption of electric power in this work allows of the use of a buffer battery to store power during the descent of the cage. Steam gives no corresponding advantage.

Its large capacity for overload gives the electric motor an advantage also in the treatment of the ore after it has been raised. It serves well, for example, for the coal washery, for screening and grinding, for crushing and concentration of ores, and for the charging and drawing of coke ovens. It is highly adapted also to the conveyors, endless belts, and other transport machinery and to the operation of air compressors for rock drills, etc. It is impossible to do more than suggest a few of the many possible installations. It is well to note, however, that the motors are generally placed in a special location and enclosed so as to be removed from the action of injurious gases, etc., which might cause them damage. In such case the machinery may be belt-driven.

The endless-belt conveyor shown in Figure 30 is a Siemens & Halske installation for the handling of coal and is operated by a 15-horse-power motor. The Westinghouse Company furnished the Oak Bank Oil Co., in Scotland, with a 30-horse-power motor for driving a crusher for clay-slate and a 10-horse-power motor for the conveyor bringing the slate. A stamp mill run by a Johnson & Philips motor is at work at the Raub gold mines. At the Scharnhorst shaft is a coal washer, a mud pump, a screen, a breaker, and an elevator driven by Helios asynchronous polyphase motors of capacities running from 10 to 100 horse power. At the Hollertzug shaft the Allgemeine Elek-

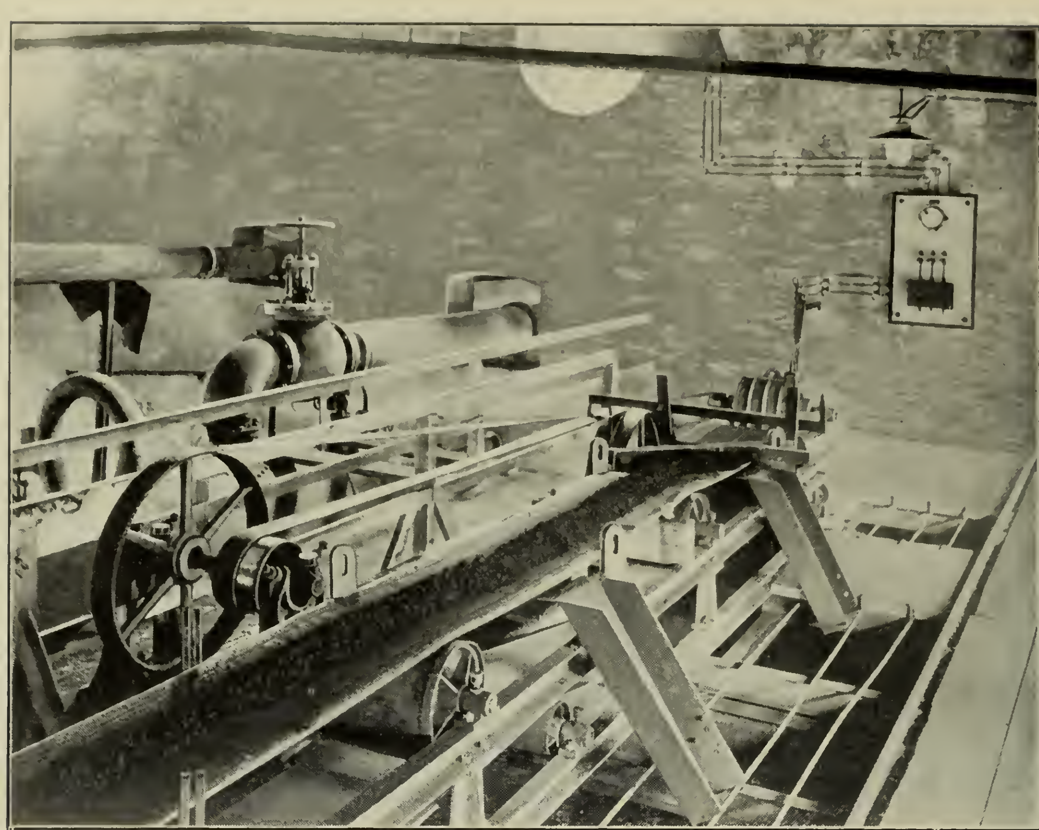


FIG. 30. ENDLESS-BELT CONVEYOR FOR HANDLING COAL.

tricitäts Gesellschaft put in a three-cylinder air compressor driven by a 40-horse-power motor.

A notable plant is that supplied by the Schückert company to the Altgemeinde Bockwa at Zwickau. It comprises two motors for the preliminary treatment, one for the washing, two for the lifts, one for a circular saw, one for a forge blower, etc. Important installations of the same kind have been made by Ganz also, as notably at Vajda-Hunyad, at the mines of Count Larisch-Mönnich, etc.

This brief *résumé* does not begin to exhaust the subject, but it may serve to make two points clear. The first is the activity which reigns in Europe in the introduction of electric mining machinery. The second is the economy which this introduction may secure. I will cite but two examples in closing.

Prior to the introduction of electricity, the Burma Ruby Mines were unable to make any dividends, the expense of operation being too high. Since its adoption, the expenses have been reduced, by the sum of £6,000 per annum, permitting the payment of profits. And at the Sheba mine, the economy in operating expenses since the introduction of electric power in 1896 has amounted to £10,000 per annum.

ALUMINIUM CONDUCTORS FOR ELECTRIC TRANSMISSION LINES.

By Alton D. Adams.

The substitution of aluminium for copper in electric-power transmission lines, though of much importance technically, industrially, and commercially, has been little discussed and the literature of the subject is scanty. Mr. Adams' brief but satisfactory presentation of the matter as it appears in the light of present conditions and immediate prospects is therefore of much interest and value. It will appeal particularly to those of our readers and correspondents who have recently asked for information on this phase of practice.—THE EDITORS.

ALUMINIUM lines are now employed for the three longest electrical transmissions in North America. In the longest single line, that from Electra power house to San Francisco, a distance of 154 miles, aluminium is the only conductor used. The 144-mile transmission between Colgate and Oakland is carried out with three aluminium and three copper line wires. For the third transmission in point of length, that from Shawinigan Falls to Montreal, a distance of 85 miles, three aluminium conductors are employed.

The three transmissions just named have unusually large capacities as well as superlative lengths, the generators in the Electra plant being rated at 10,000, in the Colgate plant at 11,250, and in the Shawinigan plant at 7,500 kilowatts. Weight and cost of such lines are very large. For the three number 0000 aluminium conductors, 144 miles each in length, between Colgate and Oakland, the total weight must be about 440,067 pounds, costing $132,020 at 30 cents per pound. Between Electra and Mission San Jose, where the line branches, is 100 miles of the 154-mile transmission from Electra to San Francisco. On the Electra and Mission San Jose section the aluminium conductors comprise three stranded cables of 471,034 circular mils each in sectional area and with a total weight of about 721,200 pounds. This section alone of the line in question would have cost $216,360 at 30 cents per pound. The 85-mile aluminium line from Shawinigan Falls to Montreal is made up of three stranded conductors each with a sectional area of 183,708 circular mils. All three conductors have a combined weight of about 225,300 pounds and at 30 cents per pound would have cost $67,590.

Aluminium lines are not confined to new transmissions but are also found in additions to those where copper conductors were at first used. Thus, the third transmission circuit between the power house at Niagara Falls and the terminal house in Buffalo, a distance of 20 miles by the new pole line, was formed of three aluminium cables each with an area of 500,000 circular mils, though the six conductors of the two previous circuits were each 350,000 circular mil copper.

From these examples it may be seen that copper has lost its former place as the only conductor to be seriously considered for transmission circuits. Aluminium has not only disputed this claim for copper but has actually gained the most conspicuous place in long transmission lines. This victory of aluminium has been won in hard competition. The decisive factor has been that of cost for a circuit of given length and resistance.

From the standpoint of cross-sectional area aluminium is inferior to copper as an electrical conductor. Comparing wires of equal sizes and lengths the aluminium have only 60 per cent. of the conductivity of the copper, so that an aluminium wire must have 1.66 times the sectional area of a copper wire of the same length in order to offer an equal electrical resistance. As round wires vary in sectional areas with the squares of their diameters, an aluminium wire must have a diameter 1.28 times that of a copper wire of equal length in order to offer the same conductivity.

The inferiority of aluminium as an electrical conductor in terms of sectional area is more than offset by its superiority over copper in terms of weight. One pound of aluminium drawn into a wire of any length will have a sectional area 3.33 times as great as one pound of copper in a wire of equal length. This follows from the fact that the weight of copper is 555 pounds while that of aluminium is only 167 pounds per cubic foot, so that for equal weights the bulk of the latter is 3.33 times that of the former metal. As the aluminium wire has equal length with and 3.33 times the sectional area of the copper wire of the same weight, the electrical conductivity of the former is $3.33 \div 1.66 = 2$ times that of the latter. Hence, for equal resistances, the weight of an aluminium is only one half as great as that of a copper wire of the same length. From this fact it is evident that when the price per pound of aluminium is anything less than twice the price of copper, the former is the cheaper metal for a transmission line of any required length and electrical resistance.

The tensile strength of both soft copper and of aluminium wire is about 33,000 pounds per square inch of section. For wires of equal length and resistance the aluminium is therefore 66 per cent. stronger because its area is 66 per cent. greater than that of a soft copper wire. Medium hard drawn copper wire such as is most commonly used for transmission lines has a tensile strength of about 45,000 pounds per square inch, but even compared with this grade of copper the aluminium wire of equal length and resistance has the advantage in tensile strength. While the aluminium line is thus stronger than an equivalent one of copper, the weight of the former is only one-half that of the latter, so that the distance between poles may be increased, or the sizes of poles, crossarms, and pins decreased with aluminium wires. In one respect the strain on poles that carry aluminium may be greater than that on poles with equivalent copper lines, namely in that of wind pressure. A wind that blows in any direction other than parallel with a transmission line tends to break the poles at the ground and prostrate the line in a direction at right angles to its course. The total wind pressure in any case is obviously proportional to the extent of the surface on which it acts, and this surface is measured by one-half of the external area of all the poles and wires in a given length of line. As the aluminium wire must have a diameter 28 per cent. greater than that of copper wire of equal length, one-half of the total wire surface will also be 28 per cent. greater for the former metal. This carries with it an increase of 28 per cent. in that portion of the wind pressure due to wire surface. In good practice the number of transmission wires per pole line is often only three, and seldom more than six, so that the surface areas of these wires may be no greater than that of the poles. It follows that the increase of 28 per cent. in the surface of wires may correspond to a much smaller percentage of increase for the entire area exposed to wind pressure. Such small difference as exists between the total wind pressures on aluminium and copper lines of equal conductivity is of slight importance in view of the general practice by which some straight as well as the curved portions of transmission lines are now secured by guys or struts at right angles to the direction of the wires.

Vibration of transmission lines and the consequent tendency of crossarms, pins, insulators and of the wires to work loose is much less with aluminium than with copper conductors as ordinarily strung, because of the greater sag between poles given the former, and also, probably, because of their smaller weight. An illustration of this sort may be seen on the old and new transmission lines between Niagara

Falls and Buffalo. The two old copper circuits consist of six cables of 350,000 circular mils section each on one line of poles, and are strung with only a moderate sag. In a strong wind these copper conductors swing and vibrate in such a way that their poles, pins, and crossarms are thrown into a vibration that tends to work all attachments loose. The new circuit consists of three 500,000 circular mil aluminium conductors on a separate pole line strung with a large sag between poles, and these conductors take nearly fixed positions in planes at angles with the vertical in a strong wind, but cause little or no vibration of their supports. One reason for the greater sag of the aluminium over that of the copper conductors in this case is the fact that the poles carrying the former are 140 feet apart while the distance between the poles for the latter is only 70 feet, on straight sections of the lines.

The necessity for greater sag in aluminium than in copper conductors, even where the span lengths are equal, arises from the greater coefficient of expansion possessed by the former metal. Between 32 and 212 degrees Fahrenheit aluminium expands about 0.0022, and copper 0.0016 of its length, so that the change in length is 40 per cent. greater in the former than in the latter metal. The conductors in any case must have enough sag between poles to provide for contraction in the coldest weather, and it follows that the necessary sag of aluminium wires will be greater than that of copper at ordinary temperature.

In pure air aluminium is even more free from oxidation than copper, but where exposed to the fumes of chemical works, to chlorine compounds, or to fatty acids, the metal is rapidly attacked. For this reason aluminium conductors should have a waterproof covering where exposed to any of these chemicals. The aluminium line between Niagara Falls and Buffalo is bare for most of its length, but in the vicinity of the large chemical works at the former place the wires are covered with a braid treated with asphaltum. Aluminium alloyed with sodium, its most common impurity, is quickly corroded in moist air and should be carefully avoided. All of the properties of aluminium here mentioned relate to the pure metal unless otherwise stated, and its alloys should not, as a rule, be considered for transmission lines. As aluminium is electropositive to most other metals the soldering of its joints is quite sure to result in electrolytic corrosion unless the joints are thoroughly protected from moisture, a result that is hard to attain with bare wires. The better practice is to avoid the use of solder and rely on mechanical joints. A good joint may be made by slipping the roughened ends of wires to be connected through an aluminium tube of oval section, so that one wire sticks out at each end, then twisting the tube and wires and giving each of the latter a turn about the other. Aluminium may be welded electrically and also by hammering at a certain temperature, but these processes are not convenient for line construction. Especial care is necessary to avoid scarring or cutting into aluminium wires, as may be done when they are tied to their insulators. Aluminium tie wires should be used exclusively. To avoid the greater danger of damage to solid wires and also to obtain greater strength and flexibility, aluminium conductors are most frequently used in the form of cables. The sizes of wires that go to make up these cables commonly range from number 6 to 9 B & S gauge for widely different cable sections. Thus the 183,708 circular mil aluminium cable between Shawinigan Falls and Montreal is made up of seven number 6 wires, and the 471,034 circular mil cable between Electra and Mission San Jose contains thirty-seven number 9 wires. From the Farmington River to Hartford each 336,-420 circular mil cable has exceptionally large strands of approximately number 3 wire. It appears from the description of a 43-mile line in California, Vol. XVII, A. I. E. E., page 345, that a solid aluminium wire of 294 mils diameter, or number 1 B & S gauge, can be used without trouble from breaks, and the same is probably true for even larger sizes. This wire was fully tested by Dr. A. E. Kennelly and its properties reported as follows:

Diameter, 293.9 mils.
Pounds per mile, 419.4.
Resistance per mil foot, 17.6 ohms at 25° C.
Resistance per mile at 25° C., 1.00773 ohms.
Conductivity as to copper of same size, 59.9 per cent.
Number of twists in six inches for fracture, 17.9.
Tensile strength per square inch, 32,898 pounds.

This wire also stood the test of wrapping six times about its own diameter, and then unwrapping and wrapping again. It was found in tests for tensile strength that the wire in question took a permanent set at very small loads, but that at points between 14,000 and 17,000 pounds per square inch the permanent set began to increase very rapidly. From this it appears that aluminium wires and cables should be given enough sag between poles so that in the coldest weather the strains on them shall not exceed about 15,000 pounds per square inch. This rather low safe working load is a disadvantage that aluminium shares with copper. From the figures just given it is evident that the strains on aluminium conductors during their erection should not exceed one-half of the ultimate strength in any case, lest their sectional areas be reduced.

ALUMINIUM CABLES IN TRANSMISSION SYSTEMS.

Locations.	Number of cables.	Miles of each.	Circular mils of each.	Strands per cable.	Size of strands. B. & S. G. Approximate.
Niagara Falls to Buffalo......	3	20	500,000	..	..
Shawinigan Falls to Montreal..	3	85	183,708	7	6
Electra to Mission San Jose..	3	100	471,034	37	9
Colgate to Oakland	3	144	211,000	7	5-6
Farmington River to Hartford.	3	11	336,420	7	3
Lewiston, Me.	3	3.5	144,688	7	8
Ludlow, Mass.	6	4.5	135,247	7	7

This table of transmission systems using aluminium conductors is far from exhaustive. Aluminium is also being used to distribute energy to the sub-stations of long electric railways, as on the Aurora and Chicago which connects cities about forty miles apart. The lower cost of aluminium conductors is also leading to their adoption instead of copper in city distribution of light and power. Thus at Manchester, New Hampshire, the local electric lines include about four miles each of 500,000 and 750,000 circular mil aluminium cable with weatherproof insulation. The larger of these cables contains thirty-seven strands of about number 7 wire.

As may be seen from the foregoing facts, the choice of copper or aluminium for a transmission line should turn mainly on the cost of conductors of the required length and resistance in each metal. So nearly balanced are the mechanical and chemical properties of the two metals that not more than a very small premium should be paid for the privilege of using copper. As already pointed out, the costs of aluminium and copper conductors of given length and resistance are equal when the price per pound of aluminium wire is twice that of copper. During most of the time for several years the price of aluminium has been well below double the copper figures, and the advantage has been with aluminium conductors. With the two metals at the same price per pound aluminium would cost only one-half as much as equivalent copper conductors. When the price of aluminium is 50 per cent. greater per pound than that of copper, the use of the former metal effects a saving of 25 per cent. For the new Niagara and Buffalo line, completed early in 1901, aluminium was selected because it effected a saving of about 12 per cent. over the cost of copper. All of the aluminium lines here mentioned, except the short one near Hartford, were completed during or since 1900. Most of the facts here stated as to the line between Niagara Falls and Buffalo are drawn from Vol. XVIII, A. I. E. E., at pages 520 and 521.

The greater diameter of aluminium over equivalent copper conductors has advantages in transmission with alternating current or at very high voltages. Inductance, by which the necessary voltage at alternating stations for a given effective line voltage is increased, varies inversely in amount with the diameter of the conductors employed, other factors remaining the same. The amount of inductance in any case is thus less with aluminium than with equivalent copper conductors. At high voltages, say of 40,000 or more, the constant silent loss of energy from one conductor to another of the same circuit through the air tends to become large and even prohibitive in amount. This loss is greater, other factors being constant, the smaller the diameter of the conductors in the line. It follows that this loss is more serious the smaller the power to be transmitted, because the smaller the diameter of the line wires. The silent passage of energy from wire to wire increases directly with the length of line and thus operates as a limit to long transmissions. Aluminium conductors, having larger diameters for any given length and resistance than those of copper, extend the radius of transmission for large powers and increase the number of practicable transmissions of smaller powers.

A PROJECT FOR A CAPITALIZED LABOR ORGANIZATION.

By Casper L. Redfield.

The problem of adjusting the interests of employers and employees on some practical working basis is one which may well occupy the present attention of the ablest minds. Conventional institutions seem to be unequal to it, and unconventional thought is cordially welcome. Mr. Redfield's scheme is probably bristling with difficulties—some of them, indeed, he recognizes so frankly as to leave them for the present without even an attempt at discussion. Such, for example, is the initial underwriting of the scheme. Another example might be the fulfillment of the guarantee of dividends. It is even questionable whether any practicable capitalization could secure a sufficiently substantial interest in a sufficient number of concerns to exercise a material influence on their labor relations. The idea is submitted by the editors, as, we take it, it is by the author—as a suggestion along unhackneyed lines. Comment and criticism are not only permissible; they are earnestly invited.—The Editors.

IT has often been said that the interests of capital and labor are identical, but a record of the labor situation at any time is evidence that this identity of interest is not sufficient to prevent conflicts which are costly alike to employer and employee. The fact is, there are conflicting interests as well as identical interests, and the conflicts between capital and labor come from these conflicting interests. Work is healthy, but the workman does not work for his health any more than the capitalist goes into business for his health. Each is after as large a portion as possible of that thing which is the product of the united efforts of capital and labor, and the trouble lies in the division of the spoils.

The mediæval idea of acquiring riches was for one body of men to attack and rob a neighboring body, but one of the lessons of modern civilization is that men with conflicting interests can make more profit by business transactions than they can by warfare. If the man on the south side cannot complete a business deal with the man on the north side, he does not waste his energies in quarreling. He utilizes these energies in carrying out a deal with the man on the east side and with the man on the west side, and at a later date he finds that his forbearance has enabled him to consummate a profitable transaction with the north-side man. This is business.

Today the relationship between capital and labor is a survival of the mediæval idea of loot. If a business relationship is to be substituted for this policy of piracy and plunder, then the initiative must be taken by the business man and not by the dreamer. The man who knows must help, must guide, and must instruct the man who does not know.

The workingman feels that in any business transaction the trained business man is the shrewder individual of the two; hence the workingman looks with suspicion upon any proposition the aim of which is to tie him to his employer by making him a small stockholder in his employer's business. He strenuously objects to being caught in an embarrassing contract as the result of swallowing a pitifully small bait. It is therefore evident that if the capitalist is to establish with the laborer the only kind of a relationship which can be profitable to both, he must not only be perfectly fair but he must remove from his proposition every suspicion of a trap.

The plan of selling or of giving small blocks of stock to employees and the plan of profit sharing are palliative, not curative measures. At best they are only local in their application. Socialism is a dream which will not be accepted by energetic and enterprising men, and which, if put in force, would be destructive of that individual initiative which is the precursor of progress.

It often happens that of many things proposed no one is effective, but that a proper combination of these various things will accomplish the desired result. The object of this article is to bring together several scattered elements in the form of a proposition intended to create a business relationship, not between individual employers and their employees, but between capital as a whole and labor as a whole. This proposition takes the form of a capitalized labor organization, the main object of which is for the organization as an organization to own good-sized blocks of stock in corporations employing labor of the kind which constitutes the organization. Without further preliminary we will plunge directly into the proposed form of organization and afterwards discuss some of the matters relating to it.

As an example of an organization which is not the easiest nor the most difficult to form, let us assume a Machinists' Corporation with a capital stock of $10,000,000 divided into shares of $10 each. For the purpose of keeping the stock widely distributed and the number of stockholders large, we will assume the limit of holdings of any one person to be $1,000. Besides owning stock in manufactories employing machinists, the objects of the corporation are to be securing employment for its members on the best terms obtainable, and the promotion of the general welfare of machinists. For the purpose of keeping such an organization in a line in which it will be of value to both capital and labor certain rules or by-laws will be required, of which the following are examples:—

1—The corporation will take no part in any labor dispute.

2—Membership in any labor organization shall in no way affect any one's rights to become a stockholder in this corporation.

3—No stock shall be sold to any person other than those engaged in making, using, or selling machine tools.

4—No transfer of stock from one person to another shall be recognized.

5—The corporation will at all times, and on demand, redeem stock at par.

6—All stockholders are guaranteed annual dividends of not less than 6 per cent.

7—A bureau of employment will be formed and offices maintained at suitable places.

8—Stockholders will be charged a nominal fee for each situation secured for them, and other machinists will be charged a slightly higher fee for the same service.

9—The officers of the corporation shall, from time to time and by instructions of the board of directors, use the money accumulating in the treasury from the sale of stock of the corporation to purchase stock in manufactories using machine tools.

10—The secretary shall promptly notify all stockholders of each purchase made.

It will be observed that there is not only a guarantee of a 6 per cent dividend, but the corporation also agrees to redeem its own stock on demand. As there are also certain expenses to be met, it will be evident that before such a corporation can be formed there must be a supply of money on hand. We will assume for the present that some genie has furnished it, and that there is a fund which may be drawn upon for all legitimate expenses until the corporation has an income of its own sufficient for the purpose of meeting its running expenses and providing the guaranteed dividend.

With the corporation formed and a guarantee fund on hand, machinists are invited to purchase stock. When the prospective stockholder learns that he has something to gain and nothing to lose, that his liberty is not curtailed in any way, and that he can back out at any time without loss, he will not be slow to enter into such an arrangement to the limit of his financial ability. There are several immediate advantages to him and a number of prospective ones that will appear under a successful management of the corporation. Among the immediate advantages to the workman may be noted the following:

He has a safe place for his money and he can get it at any time; he is in a powerful organization of his fellows and does not have the feeling like that of a cat in a strange garret which comes from being a small stockholder among big stockholders; and he has improved opportunities of obtaining a situation should he lose the one he has.

In due course of time our prospective corporation has 10,000 stockholders, has purchased $200,000 of the capital stock of dividend-paying manufacturing companies, and has notified all of its stockholders of the extent and kind of these purchases. Among the purchases made would be an interest in the Smith Co., manufacturers of lathes and planers; an interest in the Jones Co., manufacturers of milling machines and drill presses; and an interest in the Brown Co., manufacturers of machinists' small tools. As these 10,000 machinists buy a good many small tools for their own use and as they have a financial interest in the dividends of the Brown Co., they will buy the Brown tools in preference to other tools. While the influence of one machinist is small the influence of 10,000 machinists is great, and all of these 10,000 machinists favor the Smith machines and the Jones machines. As a consequence of this the sales of these machines increase at the expense of the sales of the machines of their competitors. The Smith Co., the Jones Co., and the Brown Co. not only reap all the advantages that they would have by getting their own employees to own part of their stock, but they reap the additional advantages of widespread influence.

Under these conditions it will not be long before the Johnson Co. and the Jackson Co. realize the importance of having the Machinists' Corporation own part of their stock, and they will offer it at a discount from market value. In fact, as a business proposition, it will pay the Johnson Co. and the Jackson Co. to donate large blocks of stock and charge the expense to advertising and to improvements. The value received from this form of investment would be greater than from a similar sum of money invested in almost any other way.

Many employers are finding it to their advantage to sell or even to give stock to their employees. Stock tranferred to a corporation of employees would have all the effects that could be obtained by the same stock transfered to individual employees, and in addition thereto would have many other effects. Besides the advertising features there would be only one man to deal with—the representative of the corporation, the titular stockholder. The individual employees not being direct stockholders would not and could not seek to interfere with the management of the business. In case of labor troubles originating elsewhere there would be less pressure brought upon the employees of a company which has transferred part of its stock to a corporation in which all of the working men were interested. By common consent such a company would be exempt from strikes that would menace the prosperity of rival concerns. This common consent would arise from the fact that a very great number of workmen would be deriving a benefit from the dividend-paying power of this company. Even in the case of dissatisfaction among the employees of such a company, there would be strong influence among other workmen to have the dispute settled amicably.

With all these advantages accruing to a manufacturer by reason of part of the stock of his company being held by the employee corporation, it would not be long before the corporation would hold dividend-paying stock of a value much above the actual amount of cash involved. As a consequence the income of the corporation would soon exceed the sum necessary to pay all expenses and give 6 per cent to its stockholders. When this time came the machinist would realize some of the prospective benefits that he did not perceive at the time he first purchased stock in the corporation. He would find that he had not only saved some of the money which he would otherwise have squandered, but that this saving was bringing him an income he would not have received but for his purchase. He would find that the regularity of his employment was not so often interrupted by strikes, and hence, that the total wages earned would be greater. He would find that employers would give him a preference, both in employment and in amount of wages, over employees not interested in such a corporation. He would feel that although his actual interest in any particular manufacturing concern was very small yet he and his associates, though their representative—the titular stockholder—exerted a powerful influence by reason of the large block of stock held and the corresponding vote at the stockholders' meetings.

It is not the intention to indicate all of the preliminaries to the formation of such a corporation, nor all of the consequences arising from its organization. The real point is, can such a corporation be formed and carried to a successful issue? If it can be formed and made successful will it tend to eliminate or even to diminish labor troubles? I believe that these questions should be answered in the affirmative. The real answer, however, will depend upon the good sense and the fairness of the promoters. That these promoters must be business men acting in conjunction with some person or persons known to be friendly to labor, and that these business men must furnish the fund necessary to meet preliminary expenses and the guarantees relating to stock and dividends, goes without saying. If they do furnish such a fund and promote an organization which will be financially profitable to workingmen without restricting their freedom in any way, then there is no doubt but workingmen will join it in large numbers. The first persons to be attracted to such an organization would be the best workingmen, those independent and enterprising individuals who refuse to be dictated to by labor unions. To these would soon be added those persons who now join labor unions only from a matter of policy.

With such a corporation formed, the stockholders would elect their board of directors in the regular order, and the directors would elect the officers. These officers would be the only persons with whom the manufacturers would have any dealings in regard to the management of business, and each manufacturer would meet one of these men on exactly the same grounds that he would meet any other large stockholder. Furthermore, this titular stockholder would have no more to say about the employment of labor than would any other stockholder. The relationship should be a strictly business one. The mere fact that the actual owners of this stock were certain workingmen would of itself create a preference for these men, but an effort to use the influence of the corporation in favor of certain men would be a departure from business principles and would tend to defeat its own object.

But the crux of the whole matter is, will such corporations organized in different lines of manufacture reduce the friction between capital and labor and thus tend to prevent strikes and lock-outs? If they will do this then capitalists can afford to endow such corporations with vast sums, but if they will not do this then capitalists can not afford to give anything in this way.

Perhaps the best way to arrive at a conclusion in this matter is to consider the actions of men in the event of a labor trouble between a manufacturing concern which has sold part of its stock to a labor corporation, and the employees who are stockholders in this same corporation. While this corporation as a corporation is bound by its constitution to take no part in such a dispute and cannot intervene between employer and employee, it is in a position to exert strong influence in favor of arbitration. The corporation owns stock in the company and, through its titular stockholder, is in touch with the officers of the company. It is also in touch with the workmen because they are stockholders in the corporation. Under such conditions as these an arbitration, formal or informal, would be forced, and some of the officers of the corporation would probably be agreed upon as arbitrators. Now these arbitrators will be in a peculiar position. If they decide against the company in such a way as to injure its money-making capacity, then they are cutting off part of the dividends of the corporation and causing a corresponding injury to fall upon all of its stockholders. If they decide against the employees in such a way as to reduce wages to something less than what similar employees receive elsewhere, then they are injuring part of the stockholders in the corporation and are laying up untold troubles for themselves in the future. If they must decide such a controversy they will be eminently fair, but the probabilities are that they would use their influence to prevent a controversy of any kind. They would urge the men to make terms as individuals and not as an organization. If there were individuals who were dissatisfied with the terms that could be made in this way, then these officers would exert themselves to find satisfactory situations for these persons at other places.

It is only by some such process as this that these officers could keep themselves out of trouble and at the same time make money for the stockholders of the corporation. In other words, these officers would learn that business methods are superior to warfare, and the working men would, through their pocketbooks, learn the same thing. When they do learn this then we may have industrial peace through the substitution of business methods for the present confusion.

EDITORIAL COMMENT

THE development of the modern Cup racer, so well reviewed by Mr. Stephens in this number, affords one of the most interesting examples of the replacement of empirical by engineering methods, and not the least striking point illustrated is the manifest exactness of engineering as an applied science. Twenty years ago, when the "boat-builder" was supreme in the design of the contestants, the types produced in England and on this side were almost as far apart as they could be. It was "cutter" against "skimming dish." Every move since then has given the engineer, in some branch of the profession, a larger part in the production of the "90-footer," and every move has brought each new construction nearer to a definite ideal, until the challenger and defender of to-day show lines which only an expert could distinguish one from another.

A very good comprehensive summary of the structural changes which have attended this movement is afforded by a set of outline specifications prepared by Mr. Stephens, in further illustration of the points made in his paper. "The centerboard Cup defender of 1885," writes Mr. Stephens, "had keel, stem, and sternpost of oak, frames double sawn, of oak, planking of oak below and yellow pine above water, about 2½ inches thick, shelf of oak, clamps, bilge stringers and ceiling of yellow pine. The hull was braced by knees of oak and hackmatack. The deck was white pine, 2¼ inches thick, on oak deck beams. All spars were of Oregon pine or spruce, solid.

"The steel yacht of 1885 to 1893 had frames of steel angles, spaced about 21 inches on centers, and extending from the bottom of the keel to the deck. Her plating was steel, laid 'in-and-out'; the bottom plate of the keel with the garboards formed the ballast tank, into which molten lead was poured. Deck and floor beams were of steel angles, tied to the frames with gusset plates; there were one or two longitudinal stringers of steel angles on each side.

"The modern 90-foot Cup defender has a lead keel, first cast in a single piece, the keel plate, a bronze casting, being fastened on top of the keel by bronze lag screws. The garboards, bronze plates, lap about 18 inches on the keel, being fastened to it by several hundred bronze screws of large size. The principal members of the hull are the web frames, spaced 6 feet 8 inches on centers; these are thin steel plates, from 8 to 20 inches wide, the inner edges stiffened by light bulb angles. Similar angles join the webs and the outer plating. In connection with these web frames are numerous longitudinal stringers, T beams at each joint of the plates, and bulb angles in the center of each plate. The plates are all of bronze, laid flush, the adjoining edges riveted to the head of a T bar. The usual angle frames are introduced at 20 inch intervals, three between each pair of web frames, extending from the keel plate only up to the lowest longitudinal, merely strengthening the fin and its connection with the main portion of the hull. The deck plating is of thin steel or aluminum, carried on the webs and a system of diagonal straps, and covered with canvas. The entire interior of the hull, in particular about the foot of the mast, is braced by numerous struts and ties of steel tubing. The mast, boom and gaff are hollow, built of nickel-steel plates; the bowsprit is solid, of Oregon pine, the topsail yards and spinnaker boom of spruce or pine, hollow."

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A SCIENCE may be never so exact, and yet be ill-applied. Wisdom is not always justified of her children. New York has had to apply to the building of her subway, as she did but a short time ago to the operation of her elevated roads, the coercive power of public common sense as a remedy and corrective for ill-administered engineering. She has herself partly to blame for encouraging the temper which made possible the conditions of the past three years. Abuse of the streets by one "interest" to the vast prejudice and discomfort of much wider interests—by shops and warehouses to the prejudice of pedestrians, by truckmen to the prejudice of the entire traffic of the city, by builders to the prejudice not only of traffic but of all neighboring property—this has been the rule and the custom. It is hardly surprising that the most colossal construction New York has attempted should have been characterized by the most colossal brutality to the by-standing interests. It *is* surprising and melancholy that the brutality should have been permitted—almost invited—by those whose position gave them the power and imposed on them the duty to see that a better way was followed. In no other city of the world could such conditions exist as have disgraced New York for months past—but in what other city would the serious, matter-of-fact proposal to "cut and cover" an avenue like Broadway be seriously considered, so long as any other practicable plan for the work as a whole existed?

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WE have referred elsewhere in this issue to the retirement of Rear-Admiral Melville and to his career in connection with the Bureau of Steam Engineering of the United States navy, but his work in the broader domain of engineering at large demands notice here as well. Apart from his inspiring personality and the enthusiasm which the Admiral has invariably communicated to his associates and subordinates, his method of work may be cited as an excellent instance of the element which makes an engineer at the same time an able administrator. Many men have developed large engineering ability; others have shown the faculty of administration; and still others have been gifted with powers of research and the development of new ideas. It is unusual, however, to find these different capacities united in the same individual, and still more unusual to see such an individual placed in high official position.

In most countries the value of experience gained by years of active service is found to be sufficient reason for the retention of valuable officers in the active list, but the present rules in force in the American navy unfortunately compel the retirement of men of high ability just at the period when they may naturally be expected to be at the height of their powers. That such a method gives opportunity for the promotion of officers of lower grade cannot be denied, but it hardly seems as if this fact were a sufficient offset to the nation's loss in the retirement of such men as Melville.

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WHILE the wisdom of the policy of the United States goverment in wilfully depriving itself of the services of one of the ablest of its officers may well be questioned, occasion may at least be found to commend the practice which has enabled Admiral Melville to perform one of his greatest services to the engineering profession. In no other service in the world is such freedom as to publicity of methods and plans permitted as in that of the United States. The annual reports of the Chief of the Bureau of Steam Engineering have long been recognised as among the important engineering publications of the year. They have formed the subject of extended reviews and editorials in the technical press of London, Paris, Berlin, and Vienna, and they have placed the professional status of that Bureau in the forefront of engineering progress. Details which in other lands would have been jealously guarded under the seal of official secrecy, and the revelation of which would have created international scandals, have been permitted to be published and discussed as freely as are the professional papers of a technical society. While some have questioned the wisdom of such a liberal policy, there is absolutely no doubt in the minds of engineers that it is the only correct method to pursue. When the work of a government bureau is placed before the entire profession for scrutiny and comment there is ample assurance that that work will be of the highest grade which can be had, or that it will at once receive the adverse comment which it deserves. That the reports of Admiral Melville have been received as permanent additions to the standard literature of marine and naval engineering is sufficient evidence of the merits of his work, and ample confirmation of the wisdom of the policy of publicity which has obtained.

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The advocates of secrecy in government work doubtless hold their position because of the theory that rival nations may benefit by the information which may be permitted to become public. The fallacy of any such notion must be apparent to any one who examines the question in the light of practical experience. Parallel instances may be found among those few private establishments which decline to admit visitors, and which hedge all their operations about with a wall of mystery and exclusiveness. It is well known that such works are generally far behind those of more liberal methods, and visitors who have succeeded in penetrating behind the veil almost invariably report that the most obvious reason for the secrecy is the fact that there is nothing of value to show. The same condition undoubtedly exists in the technical departments of governments which hold to the antiquated theory of mysterious secrecy. If the truth were known they have little to show, and what there may be of merit or originality in their work is promptly made known by private channels to all who are sufficiently interested. When, through the medium of freely published reports, such as are given to the world through the various bureaus of the United States government, some fair measure of the activity and effectiveness of the work is made known, the citizens are assured of the character of the service which they as a nation are receiving, while rival governments are fully apprised of the readiness of the preparations which are being made. The policy of secrecy is that of the ostrich, burying its head in the sand, while the method of publicity is that of the self-reliant antagonist, confidently exhibiting the the strength of his weapons.

* * *

Last March comment was made in these columns upon the important question of the erection of a general building for the housing of the libraries and offices of the national engineering societies, and a suggestion was made that it might be possible to organize a realty-holding association which could provide such a structure without any apprehensions as to undue predominance of any of the societies in the work. Since that time the remarkable offer of Mr. Andrew Carnegie to provide a million dollars for the erection of such a building has been made public, and the success of the plan is wholly assured.

Of the great value of this munificent gift to the engineering profession nothing can be said which is not at once suggested to every one. It must facilitate to a remarkable degree the work of all the associations who are so favored as to be admitted to partake in it, and it cannot fail to stimulate activity and development in every line of engineering work.

Of the five bodies which have been invited to accept the benefits of Mr. Carnegie's offer four have already signified their acceptance and appreciation. The fifth is doubtless hesitating only because of the fact that it has so recently expended a large sum in the erection of an extensive and beautiful house of its own. The Engineer's Club had already under consideration the building of a new house, the American Society of Mechanical Engineers owns a house which it has already outgrown, and which in the course of municipal improvement must soon be considered unsuitable, while the American Institute of Mining Engineers and the American Institute of Electrical Engineers, being without houses of their own, were free from any hampering considerations. That the possession of their present handsome building can deter the American Society of Civil Engineers from partaking in the acceptance of Mr. Carnegie's gift we can hardly believe. As we have already written: "Engineers are notably men of change, and there is no great railway company, for example, which would hesitate to tear down and remodel or remove a newly-built terminal if sufficient advantage could be shown, and no engineer but would advise such action if consulted about it."

It has been intimated that the American Society of Civil Engineers hesitates to join in the occupation of a building with the other national societies because of an unwillingness to co-operate with the later organizations, but such a disposition, if it exists, must be that of individuals only, and we are unwilling to think that it can be the sentiment of the membership at large. The plan involves absolutely no change in the policy or methods of administration of any of the societies, and the question as to the reality of the division of the profession into the departments of work indicated by the names of the four national associations is one of fact and not of opinion or sentiment. If, before the organization of any of the later societies, the American Society of Civil Engineers had taken steps to include all branches of the engineering profession in its ranks, it might well have held that "civil engineering" included all engineering not military, and it is probable that the younger societies would never have been organized; but having failed to rise to the situation at a time when such a broad scope might have been realized, it is now too late, and the field must remain divided. It is greatly to be hoped that an overwhelming majority of the membership of the American Society of Civil Engineers will accept the situation as it actually exists, and continue to advance the work of the profession which it has done so much to adorn in the past.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

STEAM ENGINEERING IN THE UNITED STATES NAVY.

THE WORK OF REAR-ADMIRAL MELVILLE, ENGINEER-IN-CHIEF, AND THE BUREAU OF STEAM ENGINEERING.

W. M. McFarland—Engineering News.

WITH the retirement of Rear Admiral Melville as Engineer-in-Chief of the United States Navy there comes the opportunity to review and comment upon the effective work which he has done for the development of marine and naval engineering during the past sixteen years, and this opportunity has been well seized by Mr. Walter M. McFarland in a recent issue of *Engineering News*. In reviewing Mr. McFarland's paper we also take great pleasure in noting incidents of our own experience in the course of a long friendship with the man who has done so much for the development and equipment of the service and for the engineering profession all over the world.

Rear Admiral Melville was appointed Engineer-in-Chief of the United States Navy in August, 1887, this placing him at the head of the Bureau of Steam Engineering, the appointment being made as a direct consequence of his high reputation as one of the most skilful engineers in the navy, as well as because of his magnificent record in the Arctic cruise of the Jeannette, where he had command of the only one of the boats whose crew was finally saved. The combination of engineering skill and tremendous executive ability thus exhibited pointed him out as emphatically the man to lead in the development of the engineering work of the new navy, and Secretary Whitney promptly grasped the opportunity with a wisdom fully justified by the sequence of events.

When Admiral Melville came into office the four cruisers built by John Roach, the beginning of the modern navy which was to supersede the obsolete vessels of the day, were in commission, and contracts had been placed for a few of the succeeding vessels. With these exceptions, however, all of the machinery of the vessels of the United States navy as it is to-day, has been designed and built under Admiral Melville's supervision and responsibility. The magnitude of this task may be appreciated when it is understood that it is represented by about one million horse power of steam engines, with all the immense mass of auxiliary machinery and appliances necessarily included.

This is not the place, nor indeed is space available to enumerate even the salient features of Admiral Melville's administration of the Bureau of Steam Engineering. For such information the interested engineer must be referred to that remarkable series of annual reports which have been issued by the Engineer-in-Chief during the past sixteen years. Public documents are usually dreary reading, and it is not the least of Admiral Melville's successes that his reports have been most eagerly awaited and widely discussed. This has been especially the case in other countries than the United States, since the policy of secrecy and reticence so common in most European countries is entirely absent in the American Bureau, where the latest results of government experiments and methods are freely given to the public to the great benefit of the profession at large, and, it is fully believed, to the advantage of the naval service as well.

When it is remembered that during Admiral Melville's administration he has been among the first to advocate the use of water-tube boilers for naval purposes, to develop the application of triple screws for the propulsion of fast cruisers, to urge the higher powering of battle ships, and to apply oil fuel to naval purposes, it will be seen that these reports contain a wealth of information and data not to be found elsewhere.

Mr. McFarland lays especial stress upon the persistent and effective work done by Admiral Melville, in connection with the long fight of the engineers in the United States navy for recognition of their official status. It was undoubtedly due in great measure to the personal efforts of Admiral Melville and the encouragement which he gave to other members of the Engineer Corps in the struggle that the Personnel Board was appointed by Secretary Long. This board, presided over by President Roosevelt, then Assistant Secretary of the Navy, effected a complete reorganization of the entire personnel of the navy, the engineers being consolidated with the line officers, making them executive officers, the ultimate object being to make all future naval officers primarily engineers. The recent plan of the First Lord of the Admiralty for the reorganization of the personnel of the Royal navy, while necessarily modified in detail, may undoubtedly be considered as a natural sequence of the work of the Personnel Board of the American navy. Since the action of the Navy Department in thus reorganizing the personnel, Admiral Melville has always been a consistent advocate of the enactment of satisfactory methods for enforcing the provisions of the law, these being all that is lacking for the prompt realization of the full advantages of that most important enactment.

Much of Admiral Melville's success in the administration of the Bureau of Steam Engineering has been due to his inspiring personality. Few men have the faculty of arousing in their associates and subordinates the enthusiasm which they themselves may feel in their convictions and in their ideals. Admiral Melville has always attracted to himself men capable of appreciating his plans and his work and in filling them with his own enthusiasm, and the result has been a Bureau with an *esprit de corps* almost unequalled in the annals of national affairs. To have been associated with him in any capacity was not only a liberal education in executive work, but also a mental stimulus as powerful as rare. This influence extended far beyond the limits of his official relations, and in the engineering profession in all parts of the world his striking personality has made itself felt.

Apart from the work in the naval service, work which might well be supposed to occupy all the time of even such a worker as Melville, we find numerous contributions from his powerful pen in the transactions of engineering societies and in the pages of the technical press. Thus he acted most ably as the President of the Naval Engineering Congress at the World's Fair in Chicago, in 1893. In 1898 he was unanimously elected to the high office of president of the American Society of Mechanical Engineers, while his contributions to the proceedings of the American Socitey of Naval Engineers, the society of Naval Architects and Marine Engineers, the Institution of Naval Architects, and other bodies, form a notable list. Especially may be noted his recent exhaustive paper upon the subject of the vibration of steamships and the extent to which they may be removed by balancing, this having been published in *Engineering,* and reviewed at length in these columns a few months ago.

An interesting example of the determined and effective manner in which Admiral Melville pursues a question, undeterred by the hampering influences of officialdom, is seen in the matter of the speed of the proposed 13,000-ton battle ships of the United States navy.

The designs submitted by the Board on Construction, of which Admiral Melville was a member, proposed the construction of a 13,000-ton battle ship with an armament about equal to that of a 16,000-ton vessel, together with a speed of only 16 knots. Although this report was accompanied by a strong protest on the part of Admiral Melville, together with a specific statement of his objections to the design, it received the approval of the Secretary of the Navy, inasmuch as it had the signatures of a majority of the board. Now, however, the subject has been reviewed by a communication to the Secretary by Rear-Admiral Bradford, another member of the board, protesting against the construction of such ill-proportioned vessels. Admiral Bradford's letter bears an endorsement by Admiral Melville, emphasizing the defects in the proposed designs, and the result of this action will probably be the prevention of the commission of an enormous blunder. There is little doubt that the proposed armament would be far too heavy for the vessels, both as regards space and crowding and also in respect of excessive strains due to the high pressures and muzzle-velocities of modern ordnance. Considering a battle ship as a "fighting-machine" Admiral Melville says: "It is my belief, founded upon special consideration of the subject, that the fighting value of the ship would be greatly improved and her endurance increased by giving greater speed and increasing the radius of action. The actual fighting value of the ship, even after reaching the battle line, would not be reduced by lightening armamant, for with the battery contemplated there is no doubt that continued trouble will be experienced with the gun mounts and emplacements."

Thus it will be seen that Admiral Melville's latest expression of opinion, together with the great weight which attaches to his words, may result in saving the Department from making a great blunder, and correct an important error before it is too late.

In connection with the retirement of Admiral Melville, because of his attainment of the age-limit of sixty-two years, we can only endorse the words of Mr. McFarland: "It is a great misfortune that the rule should deprive the government of his services, but inasmuch as it has recently become customary to call on retired officers of such great ability as his for special services, we have no doubt that the government will not lose the benefit of his talents."

DISINFECTION BY THE USE OF STEAM.

ADVANTAGES AND DISADVANTAGES OF SUPERHEATED STEAM FOR DISINFECTION AND STERILIZATION OF CLOTHING AND OTHER MATERIALS.

Drs. Kister & Weichardt—Gesundheits-Ingenieur.

IN the course of the increasing scope of the work of the engineer many things formerly assumed to be entirely without his domain have come into its limits. Among these may be noted the employment of steam, either saturated or superheated, for the purpose of destroying disease germs in materials supposed to be infected and yet of sufficient value to be worth saving. Thus the wholesale destruction of clothing, bedding, blankets, and similar articles which have been exposed to possible infection, might work great hardship or loss to the owners, and while the public welfare will not permit mistaken leniency, a harmless yet effective system of sterilization becomes most important. The recent affair concerning infected army blankets which were conveyed from South Africa to England to the great risk of public health, is an example of the necessity for a simple, effective, and convenient method of sterilization and disinfection applicable to such cases.

The use of steam for purposes of disinfection is by no means new, but the conditions under which it may be most effectively employed are so well set forth in a paper in a recent issue of the *Gesundheits-Ingenieur,* by Drs. Kister and Weichardt, of the Government Hygienic Institute at Hamburg, that some abstract and review of it is here given.

The serious use of steam for purposes of disinfection may be credited to Koch, whose researches in 1881 demonstrated that a current of saturated steam was a simple, effective, and economical method of destroying the germs of disease. These experiments showed that germs which required three hours' exposure to dry air at a temperature of 140° C. for their destruction, were effectually killed in 10 minutes in a current of saturated steam Later experiments by Von Esmarch have proved that a full exposure of 10 to 12 minutes to the action of steam at atmospheric pressure is sufficient to destroy all but the most resistent germs, only certain saprophytes requiring a longer exposure, and all germs of infectious diseases being killed by the shorter exposure.

Under these circumstances the use of steam for purposes of disinfection demands serious attention. Since nearly all the scientific experiments have been made upon a laboratory scale only, it is important that the constructive and operative details of the method when applied upon a large scale should be considered, and it is here that the work of the engineer joins the investigations of the physician and the biologist. Thus many of the articles to be disinfected are of large size, such as mattresses, bedding, and the like, and the economy of the method depends to a great extent upon the ability to treat large quantities of material effectively at one time, so that a large chamber, to all parts of which the steam shall have free and complete access, is essential in practice. Since many materials would suffer injury by subjection to moisture, it has been found desirable to give the articles a preliminary heating by some dry method in order to prevent excessive condensation, while a subsequent warming and drying is sometimes also desirable. It is only natural that under these conditions the use of dry, superheated steam should have been suggested, and, under the assumption that the sterilization is effected solely by the heat, superheated steam would appear to offer advantages over saturated steam for the purpose in view. The investigations of Von Esmarch, however, have demonstrated that super heated steam is not so effective as saturated steam, and upon examination the reasons for this apparent anomaly will be apparent.

While it is true that the destruction of the germs is caused by the heat, the effectiveness of the operation is largely dependent upon the thoroughness with which the steam is brought into contact with every part of the infected material. The penetration of the steam into the pores and between the interstices of substances and fabrics is materially assisted by the slight condensation which takes place of the steam which first enters. The entrapped air is thus gradually removed and replaced by fresh steam, while superheated steam, acting in many respects like highly heated dry air, proves less effective simply because it does not get into intimate contact with the infectious matter. The effective replacement of the air by the steam is also facilitated by the preliminary heating of the objects to be treated, since the expansion of the air drives much of it out of the spaces into which the steam should enter. When the objects to be disinfected are not injured by moisture, the most effective method is to subject them to a preliminary moistening, either by means of a spray or by a current of moist air, this insuring a condensation of the following steam in the pores, and a consequent thorough penetration of the steam. It is altogether possible that the best effect may be produced by a preliminary moistening, followed by superheated steam, the high heat of the latter being effectively introduced into the pores of the infected articles.

The general construction of the apparatus is as follows, modifications in the details being introduced in various designs. The cubic contents should be not less than 10 cubic metres (about 350 cubic feet) and so constructed that the articles to be sterilized may be arranged before being put in, preferably in an open carriage or truck. The walls of the chamber should be well insulated with some non-conducting covering in order that the heat may be well retained, and it is desirable that the steam be furnished from a special boiler in order that the conditions may be fully under control at all times. A system of heating pipes should be arranged around the walls of the chamber to permit preliminary dry heating when desired, and also subsequent drying. The admission of the direct steam varies, being arranged in some instances with simple inlet and exit pipes, and in others with long pipes perforated with small holes to insure a better distribution.

The usual procedure is to arrange the articles upon the car or traveling frame in such a manner as to permit the best possible access of the steam to the various parts. The car is then pushed into the chamber and the main door tightly closed. Suitable air doors, which must be provided, are left open during the application of the dry heat; the temperature being maintained at about 60° C. for at least half an hour, while the air circulates freely, this driving a large portion of the air out of the pores of the articles. The air doors are then shut, and the steam turned on, entering at a little above atmospheric pressure, and flowing freely through the chamber for about 30 minutes. The steam inlet and outlet pipes should be so placed as to insure the replacement of the entire air contents of the chamber by steam, in order to obtain the complete sterilization of articles in all parts of the chamber. The direct steam may then be shut off and the air valves opened, after which the heat in the drying coils may be continued for 10 to 15 minutes before the car is withdrawn from the chamber. By having more than one car to a chamber the operation may be rendered practically continuous, and a large quantity of material rapidly and cheaply disinfected with ease and certainty.

The original paper contains much interesting information with regard to the operation of sterilizing chambers, and the extent to which various articles are penetrated by the action of saturated and superheated steam, and should be most useful to engineers who are called upon to design such apparatus.

THE ELECTRICAL CONDUCTIVITY OF FIRE STREAMS.

AN ACCOUNT OF EXPERIMENTS TO DETERMINE THE DANGER TO WHICH FIREMEN ARE EXPOSED FROM LIVE WIRES.

Friedr. Heinicke—Elektrotechnische Zeitschrift.

IN modern cities there will often be a network of overhead wires running along the streets and over houses, and conveying electrical currents having various potentials. Many of these wires are uninsulated, and contact with them may produce disagreeable, if not dangerous results, for even if the touched wire be on a low tension telephone or telegraph circuit, it may be crossed somewhere by a high-tension light or power conductor.

When fires break out, these wires often hamper the work of the firemen, for they not only offer a mechanical obstruction to the operation of the fire extinguishing apparatus, but the possibility of receiving an electric shock keeps the firemen from approaching them too closely. Of course, the electric circuit can be broken at the central station or at some junction box, or the wires can be cut down, but this takes time, and if the wires be on a lighting circuit, may plunge a quarter of the town into darkness, which is particularly undesirable when there is a fire.

One of the supposed dangers to which firemen are exposed from live wires is that when a stream of water is directed on the wires, the current may pass through the water and then through the man who holds the hose. While the possibility of such an occurrence is admitted, there has been very little definite information on the subject, and therefore some experiments made by Herr Fried. Heinicke at the Charzow central station of the Upper Silesian Electrical Works, and published in a recent number of the *Elektrotechnische Zeitschrift,* are of interest.

Herr Heinicke directed a stream of water, under a pressure of 5 atmospheres, from a nozzle of about 12 millimeters (½ inch) diameter onto a bare live conductor, very well insulated from the earth, and which was struck by the whole section of the stream. The nozzle was also insulated from the ground, and the potential between the stream of water, at its issuance from the nozzle, and earth was measured by means of an accurate voltmeter. The distance between the nozzle and the conductor was varied, and the corresponding measurements of potential were made. Two kinds of water were used; one was rather hard and a poor conductor, and was taken direct from the regular supply, while to the other was added 0.5 per cent. of pure soda.

The resistance of the hose which conveyed the water to the nozzle was found to be 5000 ohms, and the resistance of the human body, from hand to wet earth, was assumed at 15000 ohms. With these figures, and knowing the potential of the conductor and measuring the potential at the mouth of the nozzle, the respective currents flowing through the water, the hose and the body of a man holding the nozzle were calculated. It was also assumed that a man could have a current of 0.03 ampere pass through him without injuring him.

The first set of experiments was made with a Y-connected polyphase circuit, having a voltage of 6000 between two conductors, and with a grounded neutral. The three bare copper wires had each a section of 95 square millimeters, (.15 square inch,) and were well polished. Only one of them was struck by the stream of water. The first reading was taken with the nozzle 10 centimeters distant from the wire, and at this point the potential between the stream of water and the earth was found to be 130 volts, from which it was calculated that the current passing through a man holding the nozzle would have been 0.0637 ampere. The distance was increased and at 30 centimeters (1 foot) the current through the nozzle-holder would have been only 0.0174 ampere, which could be stood with safety, though perhaps with some inconvenience. At one meter, the current would be only 0.00314 ampere, and at 125 centimeters (49 inches), no current at all would pass through the man at the nozzle. These figures were determined with the water from the regular supply mains, but when the water with 0.5 per cent. soda was used, it was found that the length of the stream had to be increased to 1 meter before a dangerous current was avoided.

A second series of experiments was made on a polyphase system with a voltage of 125, in which one phase was directly grounded. With either kind of water it was not possible to get a dangerous current, even when the distance between nozzle and conductor was reduced to 3 centimeters (1.2 inches.)

Experiments were then carried out with continuous current at 550 volts. It was only for distances of less than 8 centimeters (3.2 inches) and with the 0.5-per cent.-soda water, that a dangerous current was found. In the fourth set of experiments, with 240-volt continuous current, the distance between nozzle and wire was reduced to 5 centimeters (2 inches) without getting a current which would have endangered the man at the hose.

According to these experiments, the danger involved in playing a fire stream on live wires is not as great as has been supposed, but the quality of the water has considerable influence on the results, and experiments should be made in other places before it can be asserted that the man at the nozzle is safe from any electric currents which may by accidental causes flow through the stream.

MACHINE TOOLS FOR HIGH-SPEED STEEL.

MODIFICATIONS IN DESIGN AND POWERING TO ENABLE MAXIMUM CUTTING EFFECTS TO BE PRODUCED.

The Engineer.

IT is now generally accepted that the introduction of rapid cutting tool steels will work numerous modifications in the design and construction of the lathes and other machine tools in which they are to be used. It is not only higher speeds which must be provided, since an important element in the capacity of the new steels is the heavier cuts which can be taken. The result is that heavier and stiffer beds and frames are required, and that with the higher speeds corresponding increases in powering become necessary. These facts being accepted, it appears to be a comparatively simple matter to design acceptable tools for the modified conditions.

In a description of some improved tools made by the Tangye Tool and Electric Company, Ltd., the principles involved in such special tools are so well brought out as to demand comment.

In order that such a lathe may do its best work it should have its highest powering at its high speeds, and this means that the initial belt speed should be high.

"The first impulse of those lathe designers who have paid particular attention to the production of a lathe for high-speed steel has been to follow the design of the ordinary lathe, but gearing it more powerfully than usual. This has given good results, but cone pulleys for such work have several disadvantages, the principal one being the very high speeds at which they must run to enable the requisite power to be obtained, rendering great care necessary to prevent heating of the bearings. It has also the disadvantage that the belt will only give a low power when on the largest step of the cone —owing to this being the slowest belt speed —at the very time when most power is required. For example, a cone pulley with a 12-inch small speed and a 24-inch large speed—the countershaft running, say, at 240 revolutions—will, allowing the belt to pull 600 pounds, give about 27 brake horse-power on the smallest speed, whilst on the largest speed—which, if anything, should have rather more power—it will only give about 13½ brake horse-power."

As a mater of fact the actual amount of power used by existing lathes is frequently over estimated, mainly because of the large proportion of power consumed in the transmission, and erroneously assumed to be taken by the machines. When, therefore, the amount of power demanded for the high-speed steel work is mentioned it does not seem more than the ordinary machine is supposed to take. As soon, however, as the attempt is made to increase the resistance at the point of the tool to 3 to 10 times that formerly used, the deficiency in powering becomes apparent.

In view of the fact that the actual work performed with the new steels, when operated under the most efficient conditions, is about three times that attainable with the ordinary steels, it may well be assumed that the powering should be increased in about the same proportion, and this fact should not be lost sight of in providing for the belt speeds and widths.

There is little doubt that the ultimate effect of the general introduction of high-speed steels will work important modifications, not only in the design and powering of the tools themselves, but also in the original installation of the machinery of motive power plants.

PRACTICAL EXPERIENCE WITH SUPERHEATED STEAM.

DETAILS OF SUPERHEATER CONSTRUCTION AND EXPERIENCE WITH HIGHLY HEATED STEAM IN ENGINES.

Prof. W. H. Watkinson—Institution of Naval Architects.

IN the consideration of possible lines of improvement for the steam engine, the one point upon which engineers are generally united is the fact that the principal source of loss lies in the condensation of steam in the cylinder. In all engines of the cylinder type this loss from condensation goes on and various methods have been devised to reduce its injurious action, or if possible, to prevent it altogether. Thus corresponding and multiple-expansion have been introduced for the purpose of separating the various stages of the operation of expansion. Again, all the various arrangements of steam jackets, reheaters and similar devices have been made, in the hope of diminishing the internal wastes, but the gain from these methods has been questioned, especially when the cost of installation and operation of the apparatus has been taken into account.

The most effective method of reducing cylinder losses by condensation is that of superheating the steam before it is delivered to the engine, and in a paper recently presented to the Institution of Naval Architects by Professor W. H. Watkinson, some interesting experiences with superheated steam are given.

We have referred to the losses from condensation as taking place in cylinder engines.

"The steam turbine is the only engine in which this condensation of the steam by previously cooled internal surfaces does not take place; but the steam in turbines is, of course, wet from another cause, namely, on account of the expansion it has undergone while doing work, and the efficiency of this type of motor is also very considerably increased when the steam is superheated prior to its admission to the engine. In steam turbines the reduction in the amount of steam required when superheated steam is used is due mainly to the increased volume and the decreased frictional resistance between the rotating vanes and the steam. In steam turbines of the De Laval type, using saturated steam, the discharge from the nozzle is generally more or less intermittent, due to the intermittent choking of the nozzle with the water in the steam. When the steam is superheated the discharge from the nozzle is free and continuous, and the velocity, and therefore the efficiency of the steam, is on this account still further increased."

The various methods for reducing internal condensation other than superheating must be regarded as only palliatives, and superheating itself is the only means whereby condensation can be wholly prevented.

"An advantage incidentally obtained in most cases where superheating is adopted, follows from the reduced demand for steam on the boilers. Fewer boilers may in many cases be used, and those used may work at an easier rate; the result generally being that the efficiency of the boilers is also increased. In condensing engines, a still further advantage is derived from the fact that the use of superheated steam reduces the work to be done by the air pumps, feed pumps,and circulating pumps. In nearly all steam engines, far more steam leaks past the valves and pistons than is generally recognized. Professor Perry says: "'It is to be remembered that it is the existence of water round the piston and valves that enables leakage to be fifty times as great as if there was no water.'' By using superheated steam most of this leakage is entirely prevented, as is also the leakage at steam pipe and other joints. During superheating, although the pressure of the steam remains constant, its volume is greatly increased. The amount of heat required to superheat 1 pound of steam by 150 degrees, F., is 72 British heat units, which is only about 6 per cent. of the heat required to generate 1 pound of dry saturated steam. The increase in volume due to this additional 6 per cent. of heat averages about 30 per cent. In the case of large engines of the usual types it is not advisable to superheat the steam by more than about 200 degrees F., and is some cases there is much trouble with the valves if the degree of superheat exceeds 150 degrees F. When piston valves are used this limit can be considerably exceeded without difficulty, with a corresponding gain in efficiency. In the case of large triple expansion engines the consumption of steam could be reduced to below 8 pounds per hour per indicated horse-power by superheating the steam initially and between each stage of expansion."

In many instances the superheater is placed in the flue between the boiler and the chimney. This plan may well be adopted when the plant is a small one, and but two or three boilers are used. For larger installations Professor Watkinson prefers to use an independently fired superheater. One reason for this is that if a superheater is applied to each of a battery of boilers it is not known what each one is doing. One of the superheaters may be supplying steam nearly a temperature of red heat, whereas another, the boiler of which is being lightly fired, may be acting as a condenser. The cost of an independently arranged superheater is less than that of an apparatus attached to the boilers, and the convenience of manipulation is far greater. When the superheater is operated in connection with a gas producer a high efficiency is secured.

Professor Watkinson gives a detailed description of a form of superheater arranged for operation with gas firing, together with results of its operation. The superheater is of the small bent-tube type, the surfaces being exposed to the gases in such a manner that although they are white hot as they approach the first wall of tubes, they pass away from the superheater at a temperature of about 460 degs. F. Experience has shown that the best results cannot be obtained unless the hot gases reach the superheater at a temperature of at least 1,000 degrees F. This cannot well be accomplished with the waste gases from steam boilers unless the gases leave the boiler surfaces at a higher temperature than is consistent with the best economy. The temperature necessary for efficient chimney draught is between 500 degrees and 600 degrees F., and good boiler design should not permit the gases to escape at a temperature high enough to be most effective for purposes of superheating.

When superheaters are placed in the flues of steam boilers care must be taken to provide for the protection of the tubes during steam raising, as the absence of any flow of steam through the tubes permits the heat to accumulate. In some systems an arrangement is provided whereby the tubes may be flooded with water during the period of firing. Professor Watkinson has devised a shunt method for diverting the products of combustion from the superheater until the flow of steam is established. Other systems involve the use of cooling water-coils or similar devices but all these, which are really necessary for superheaters set in boiler flues, are entirely unnecessary with the independently-fired apparatus.

The economy due to superheating has been effectively demonstrated in various tests and researches. In a case cited by Professor Watkinson, at a colliery in Lanarkshire, six boilers were required before the installation of the superheater, whereas afterwards but four were needed. In such a case the economy is not only that represented by the diminished coal consumption since the saving in labor, repairs, interest and depreciation upon the two boilers must also be considered.

The injurious action of highly heated steam upon the lubricants and upon the rubbing surfaces has been a matter for serious consideration. With the modern high-temperature cylinder oils, however, this injurious action has been reduced to a minimum, and when the lubricant is not used to excess, no harm need be anticipated. In many cases oil may be almost entirely dispensed with to marked advantage.

"In starting a new engine, or one with new piston rings, it is not advisable to attempt to use highly superheated steam until the valves, cylinder, and piston rings have acquired a glassy surface. If the superheat for the first few days be kept at, say, 40 degrees F., there should be no trouble, and after this time the superheat may be gradually increased until the maximum superheat suitable for the engine is attained. The above precautions are especially important in the case of engines having a high rotative speed. When the valves, cylinder, and piston rings have acquired a glassy surface, internal lubrication does not appear to be absolutely necessary." Professor Watkinson states that he has had an engine under observation for a considerable period, which is running most satisfactorily without internal lubrication, although the temperature of the steam is 500 degrees F.

WATER POWER IN BAVARIA.

A STUDY OF THE AVAILABLE HYDRAULIC POWER EXISTING IN THE NORTHERN WATERSHED OF THE BAVARIAN ALPS.

O. von Miller—Verein Deutscher Ingenieure

WITH the realization that commercial and industrial surpremacy, or even existence, depends upon the command of ample sources of motive power the study of available sources of water power has attracted attention of late, not only in countries lacking in coal, but also in those in which fuel is not wanting. Thus the possible water powers of Italy have been officially investigated, with the result that that land, without coal, has already developed some of the most important hydraulic stations of Europe; as various articles in the pages of this magazine have shown. In France, the possible power to be derived from the Alps has formed the subject of several important studies by engineers of the *Ponts et Chaussées,* and the interest which has been awakened in the utilization of the "white coal" has already produced substantial results, notably in the district about Grenoble.

The abundant water power sources existing in the Bavarian Alps form the subject of a paper by Herr Oskar von Miller, appearing in the *Zeitschrift des Vereines Deutscher Ingenieure,* and the systematic manner in which the subject is presented, as well as its importance to the industrial status of the kingdom of Bavaria, renders it desirable for abstract and review.

The whole northern slope of the Alps forms a gigantic watershed, delivering the flow of melting snows through innumerable streams into two great rivers, the Rhine and the Danube, and these latter may be regarded as tail-races, so to speak, of the mill powers possible upon their slopes. Her von Miller divides the watershed into three great districts, the Swiss, fed by the Ill, the Thur, and the Aare, with its tributaries, the Saane, Emme, Reuss, Limmat, etc., and discharging into the Rhine; and the Austrian, and the Bavarian districts, drained by the Danube, and including as power streams the upper Danube itself, as well as the Iller, Lech, Isar, Inn, Salzach, and others. Leaving the Swiss streams out of consideration, and discussing mainly the streams available in Bavaria, Herr von Miller proceeds to estimate the theoretical and practical power at the disposal of the engineer. The importance of this district will be seen from the fact that already about 350,000 horse power is developed on the Bavarian and Austrian slopes, and the area has scarcely begun to be worked.

In making a detailed estimate of the total available hydraulic power of the Bavarian Alps, the method used is that of taking the fall of the various streams, as computed from the topographical maps, dividing off each stream into sections between which power stations may be placed, and computing the power for each stretch. In the upper regions the falls are naturally greater and the stations closer together, but the volume of water less than in the lower sections, and hence the distribution of power, to a certain extent, equalizes itself.

The total theoretical power in any section is readily computed from the head and volume of flow, and while in no case an absolute proportion of this theoretical amount can be utilized, yet it may be made a basis for estimating the actual power realizable. Instead of taking the available power as a constant percentage of the total, however, Herr von Miller has adopted the far more scientific method of assuming a high percentage of efficiency for the short, high falls, and a lower efficiency for the lower reaches of the respective streams. In this way he has tabulated the computations of total and effective power of the various streams in a manner which, when taken into consideration with the map, enables a very clear idea of the amount and distribution of power to be obtained. The grand total of the theoretical power available in the Bavarian Alps is computed to be 1,900,000 horse power, while, according to the conservative estimates of Herr von Miller, about 700,000 horse power of this is practically available, or seven times as much as is drawn from the falls of Niagara by the shaft and tunnel of the Cataract Company.

Naturally, the development of this power involves the installation of electrical and transmission plant; and indeed, as Herr von Miller indicates, an important demand for electrical current is for the development of electro-chemical industries. Thus the applications of hydraulically developed electrical energy for the production of aluminum, calcium carbide, and similar industries, are well known, while the possible uses in connection with the manufacture of glass, cyanides, alkalies, etc., must be considered, as well as the smelting of iron and the fining of steel.

The important element in comparing the relative value of hydraulic power with steam is the cost, and this point is examined by Herr von Miller with especial reference to the conditions existing in the Bavarian watershed. As in the case of the relative efficiency, the value of the higher falls is greater than that of the lower reaches of the streams, since, in the former instances the first cost of installation is less per horse power than in the latter.

Thus in the case of a fall of 1.5 meter, developing 240 effective horse power, the cost of installation was 1,000 marks per horse power. For a fall of 3 meters and the development of the same amount of power, the cost fell to 650 marks per horse power; while for a plant operating under a head of 80 meters and generating 6,000 horse power, the installation cost was only 200 marks per horse power. These facts should lead to the development of the high falls in the upper district, since not only is the original cost of plant kept at a minimum, but a higher operative efficiency is also attained. In this connection, however, the attendant costs due to the relative inaccessibility should be considered, as they may have an important bearing upon the commercial value of the site thereafter, since the value of the undertaking must depend largely upon the transportation facilities.

The discussion which has been given in this paper to the water power available in Bavaria should form an excellent model for investigations and reports elsewhere. There is little doubt that in the near future the power resources of a country will be deemed as fitting a subject for survey and public report as its mineral deposits, its agricultural areas or any other of its industrial potentialities.

Even if the utilization of the power be not in the hands of the State the general investigation of the subject may well be made on official matter, both because of the legal questions involved and because in no other way can the necessary publicity as to facts be secured.

THE DIESEL MOTOR IN ENGLAND.

COMPARATIVE DATA AND RESULTS OF PRACTICAL TESTS OF DIESEL OIL ENGINES IN ACTUAL SERVICE IN ENGLAND.

H. Ade Clark—Institution of Mechanical Engineers.

AT various intervals since the presentation of the rational heat motor of Herr Rudolph Diesel at the Cassel meeting of the Verein Deutscher Ingenieure we have referred to its progress in these columns. Naturally the development of the motor has been most marked in Germany, where it has had the advantage of the experienced attention of the inventor and his associates, while considerations of practical economy have led to its adoption in Austria and in Southern Russia, where the abundant supply of liquid fuel has rendered it especially applicable. In Great Britain, however, apart from some experimental work early in the history of the invention, but little has been done until recently.

About a year ago a Diesel motor of 35-horse-power, built in Germany, was installed by the Harrogate Corporation, and in order to confirm and verify the remarkable results which had been obtained on the Continent and in America, Mr. H. Ade Clark, of the Yorkshire College, Leeds, took the opportunity of testing this motor. The results of these and some other tests are embodied in a paper presented by Mr. Clark at the recent meeting of the Institution of Mechanical Engineers, forming a valuable and interesting addition to our stock of information concerning internal-combustion motors.

Mr. Clark begins his paper with a general description of the construction and operation of the motor, to which but brief reference can be made here, as it has already been more fully set forth in these pages. Briefly the motor is an internal-combustion engine of the four-cycle or Beau-de-Rochas type in which an attempt is made to approximate, as closely as practical conditions will permit, to the ideal cycle of Carnot. Taking the four portions of the cycle in succession, the first out-stroke admits air to the cylinder, the next in-stroke compresses it adiabatically to a pressure of about 500 pounds per square inch, producing a temperature of about 1000 degrees F.; the liquid fuel is then injected and ignited by the high temperature of the air, and burns, producing isothermal combustion, followed by adiabatic expansion, this being the power stroke; finally, the return is the exhaust stroke, the contents of the cylinder being discharged, and the cycle completed. The high ignition temperature, the excess of oxygen present, and the freedom for combustion due to the pressure, all unite to produce a remarkably complete combustion even of thick and inferior oils, petroleum residues burning as freely and completely in the cylinder as benzine or gasoline. The close approximation to the cycle of maximum efficiency renders the motor capable of returning a much greater proportion of the fuel in useful work than has hitherto been possible, tests made in Germany, Belgium, France, and the United States agreeing in showing thermal efficiencies of 37 to 39 per cent., or more than double that attainable in the best large steam engines, and 50 per cent. higher than that of other internal-combustion motors.

The tests of Mr. Ade Clark being the first trials of the first Diesel motor put to work in England, naturally attracted much attention, and the fullness with which the data and results are tabulated in the paper leaves little to be desired. Briefly, the results fully confirm the experience obtained in other countries. The quantity of oil consumed by the engine when developing 40-horse power was 0.46 pounds per *brake* horse power, giving a thermal efficiency of 36.3 per cent. Mr. Ade Clark also gives results of a test made by him on an 80-horse power Diesel motor at the works of Messrs. Carels Frères, Ghent, Belgium, showing consumption of 0.43 pounds of oil per brake horse-power-hour and a thermal efficiency of 39.9 per cent.

These results fully confirm the records of high efficiency shown by the Diesel motor elsewhere, and should go far to demonstrate to engineers and power users in Great Britain the accuracy and value of the Continental trials. Apart from the manner in which the results check each other, it is interesting to note the improvement in the mechanical efficiency of the motor. The earlier machines showed that only about 75 per cent. of the indicated power was delivered as effective power at the brake, the remaining 25 per cent. being expended in overcoming the friction and other internal resistances; these latter owing to the high working pressures being greater than in other engines.

The mechanical efficiency of the later motors has progressed from 80 to 85 per cent., thus enabling a far greater proportion of the high thermal efficiency to be utilized, so that in this respect the motor does not fall behind other machines of its class.

An interesting portion of Mr. Ade Clark's paper is that in which he compares the actual cost of power generated by the Diesel motor, the gas engine, and the steam engine respectively. The details of these costs are gone into very fully, being tabulated and classified so as to show the proportion of capital depreciation, maintenance, and operative charges in each case. The motors compared with the Diesel are: the Crossley-Otto gas engine, supplied from a Dowson producer, and a standard high-speed compound condensing steam engine. The fuels taken are: for the Diesel, crude petroleum at 45s. od. per ton; for the gas producer, anthracite cobbles at 24s. od. per ton; and for the steam engine, coal at 12s. 6d. per ton. Including capital, depreciation, and operative costs the total cost per brake horse power works out according to Mr. Clark, as follows: Diesel motor, 0.59 penny; gas engine, 0.69 penny, and steam engine, 0.89 penny. These results will doubtless be subject to correction for various locations, according to the local price for fuel, the Diesel making a much better showing in the oil regions, while the steam engine will show a lower cost of power when situated near the pit-mouth, but as given they may be accepted as fairly average conditions in Great Britain.

While the Diesel motor, as at present designed is intended for use with oil fuel the principles involved are equally correct for gas or for powdered solid fuels, and there is every reason to believe that the principle of the combustion of the fuel in the working cylinder in accordance with a correct thermo-dynamic cycle is the true method of attaining the maximum efficiency.

So far as the oil engine is concerned the results of practical experience in Germany have shown its complete adaptability to stationary, marine, locomotive and automobile purposes, and the trials in England as reported in Mr. Ade Clark's paper fully confirm all that has been done elsewhere.

HIGH-SPEED TOOL STEELS IN ENGLAND.

DISCUSSION OF THE MERITS OF RAPID-CUTTING TOOL STEELS AND THEIR INFLUENCE ON MACHINE-TOOL DESIGN.

Institution of Mechanical Engineers.

At the Leeds meeting of the Institution Mechanical Engineers an animated discussion was elicited by a brief paper presented by Mr. H. H. Suplee, containing some notes upon the performance of high-speed tool steels at the Omaha shops of the Union Pacific Railway. The paper itself contained some verified data concerning the speeds and performances attained in the course of ordinary shop practice, showing, as has been the case elsewhere, that for heavy roughing work from three to ten times the quantity of metal could be removed by use of the new steels as had been possible with the ordinary tools.

The discussion was interesting in that it showed that up to the present time the modern tool steels were but little used in England, with the exception of some progressive establishments which were conducting experiments on their own account but were not yet prepared to make the entire results public, while in some few instances there appeared an unwillingness to accept the material as a very great advance over older tools. At the same time a number of eminent engineers showed themselves fully alive to the great importance and value of the subject, so that the discussion should prove of value as awakening public interest in the matter.

Speaking for the older methods of doing work, Mr. Joseph Barrow drew from his ripe experience some valuable features concerning the relation of the form and position of the tool in connection with maximum output, and was rather inclined to feel that when all these facts were fully considered the difference in performance between the older steels and the new material was not so great as might at first appear, but it was readily made apparent that the same care devoted to the form of the tool with the rapid steels would enable them to benefit by this experience also.

Numerous speakers, however, corroborated the greatly increased cutting capacity of the new steels, and the practical trend of the discussion bore upon the effect of the improvements upon the design of machine tools. The true position in this respect was well brought out by Mr. Hartnell, who said that his own experience showed that existing machine tools would soon break down under the severe work thrown upon them, but that he was convinced that the machines would have to go and be replaced by stronger and more heavily-powered tools. The question of increased power expended also came up for consideration, but Mr. Wicksteed called attention to the fact that the increased consumption of power was accompanied with a corresponding increase in output, and, in fact, the proportion of effective to total power is greater than when the machines are using less.

An interesting feature in connection with the introduction of rapid-cutting steels is the association of their introduction in connection with improved wage systems. When premium or bonus wage systems are introduced, by means of which the wage of the workman depends in some direct proportion to his output, his interest is awakened in all that relates to greater rapidity of production, and it is found in actual experience that improved wage systems and improved tool steels frequently go hand in hand. There is no better comment upon the value of the premium system than the fact that it aids in the development of improved methods and appliances for doing work, methods which make little or no greater demands upon the physical effort of the workman, but do develop the application of his mentality and observation.

In connection with the modifications in machine-tool design due to the imposition of heavier burdens, attention was called to the unsatisfactory plan of putting a more powerful head upon a lathe bed of older proportions, the result being what Mr. Barrow called a "hydrocephalous" lathe, a type certainly not to be desired or imitated. With any increase in powering there should certainly be given a great increase in strength and stiffness, as otherwise the machine is certain to spring under the increased stresses which will be put upon it. The modern machine tool must certainly be designed upon what has aptly been called the "anvil" principle, as opposed to the "fiddle" principle with which it has been contrasted, while the "big-headed" type should be discouraged.

THE PURIFICATION OF DRINKING WATER.

A COMPARISON OF THE PROTECTION OF GATHERING GROUNDS WITH THE EFFECTIVENESS OF FILTRATION METHODS.

S. Delépine—British Association of Waterworks Engineers.

ALTHOUGH there is a general union of opinion as to the importance and necessity for the provision of a pure water supply to cities and other communities, there is by no means a general unaminity of opinion as to the best method by which this most desirable result is to be attained. For this reason the paper of Mr. S. Delépine, the Directr of the Manchester Laboratory of Public Health, presented at the recent meeting of the British Association of Waterworks Engineers, is of present importance and interest.

Starting with the assumption that we have an original source of pure water in the rain which falls to the ground, Mr. Delépine proceeds to show how it becomes polluted.

In the first place, the air itself, above densely populated districts, is charged with bacteria. Examinations of air in various localities and at different altitudes show that in 10,000,000 cubic centimeters of air the number of bacteria ranged from 0 at heights of 2,000 to 4,000 méters in the Bernese Alps, to 55,000 in the Rue de Rivoli, Paris. Thus, even before it reaches the ground, rain water falling over densely inhabited parts becomes loaded with bacteria, chemical products, and various living organisms. Rain and snow falling through the atmosphere of large industrial towns may thus be loaded with impurities to an extent which is hardly conceivable.

Upon reaching the ground the rain water comes in contact with a very large number of bacteria. Professor Delépine gives results of a number of examinations of soils, showing the aerobic bacteria in one gramme of soil to vary from 1,600 in dry sand to 78,000,000 in street mud of large cities, so that the possibilities of contamination are very great.

"The extent to which surface waters besome loaded with soil bacteria depends upon various conditions. Water falling upon uninhabited, bare, impervious, rocky grounds, forms at once streams which remain pure until they reach cultivated regions. Rain falling upon grassy slopes, and especially upon boggy, peaty land, is generally retained for some time, unless the slopes are very steep or the ground already saturated with water. In the latter case the water carries with it to the surface streams all the surface impurities, including surface pollutions, with which it comes in contact; but when the water is retained by grass or a superficial stratum of porous soil, it gravitates more slowly towards the rivulets, and carries with it but few of the soil bacteria. This percolation continues to take place slowly after the cessation of rain, so that the water collected from small streams during dry weather is purer than that collected during rainy weather."

When the water penetrates deeply, owing to the superficial layer of porous soil being thick, an almost complete bacterial purification takes place. It is this natural method of purification which is sought to be reproduced in the construction of slow sand filters. Careful examinations of subsoil waters in which the surface of the ground is rich in bacteria, show that at depths of 2 to 5 metres there is almost a complete absence of bacteria. The real cause for the pollution of water, then, is to be found in the surface washings which find their way into streams without being filtered through suitable soil.

Thus, the manuring of land, or the presence of even a small number of human habitations in the neighborhood of feeders or reservoirs of moderate size, is attended with a marked increase of organisms, among which are frequently found fæcal bacteria growing well at the temperature of the human body.

"An increase in the number of bacteria is not in itself a sign of actual danger, but indicates, especially when there is clear evidence of the presence of bacteria usually found in the human intestine, that there is a potential danger, for where bacteria coming from healthy beings, human or animal, can find their way, those issuing from diseased individuals may also penetrate at times."

In the case of reservoirs of moderate size, in which the gathering ground may be thoroughly and carefully inspected, the sources of pollution may usually be detected. Whenever possible, this system should be adopted, and Professor Delépine is fully convinced that protection is better than filtration when it can be fully and properly carried out. Supplies from river water, however, involve purification by filtration, since it is impossible to secure a proper inspection and protective supervision of the gathering grounds. The conditions involved in successful filtration have been well laid down by Koch. These include means for meeting widely varying demands, without overworking the filters at any time; means for preventing freezing; means for regulating the flow of filtered water, and consequently the rate of filtration; and means for testing bacteriologically the water immediately after it has passed out of each filter bed. Water which is found to be insufficiently purified should be diverted from the distributing system, even though much water is lost thereby, and the most careful and constant supervision by a thoroughly competent engineer is an essential to security.

Comparing the precautions which are necessary to insure the safe operation of sand filters, with the extent and nature of the care required to protect the gathering grounds, Professor Delépine shows that in many instances the latter is the better and less costly method.

In many instances, however, polluted

water must be used for drinking purposes, and in such cases filtration is invaluable, although it cannot be considered as entirely satisfactory. Where entire sterilization is required it appears probable that the use of ozone may be found the best process available, and the experiments of a number of investigators in Germany, Holland and France, go to show the entire practicability of the progress, questions of cost alone remaining to be solved. It is not improbable that filtration followed by treatment with ozone may ultimately be adopted as combining the essentials of complete sterilization with practicable limits of cost.

In summing up the discussion of the purification of drinking water Professor Delépine concludes that:

Filtration of unpolluted water is unnecessary as a protection against disease.

Filtration of polluted water, even when well conducted, is not always an absolute safeguard against disease.

To make filtration efficient within the limits of the possible, constant skilled supervision and provision against possible breakdowns are needed. Efficient filtration involves a considerable initial and permanent expenditure.

The initial expenditure caused by the acquisition and depopulation of gathering grounds varies, and in some districts may be considerable, but this is not usually the case.

The supervision of depopulated gathering grounds requires no special skill, and may be carried out efficiently with a small permanent expenditure.

When expense is not a matter for consideration the best results are obtained by a combination of protection with well-conducted filtration; but whenever expenditure makes it a matter of necessity to choose between filtration and protection, Professor Delépine maintains that protection is better than filtration, which is really equivalent to saying that prevention is better than cure.

STREET AND ELECTRIC RAILWAYS IN AMERICA.

A UNITED STATES CENSUS REPORT SHOWING THE RAPID GROWTH OF THE STREET AND ELECTRIC RAILWAY INDUSTRY.

United States Census Bulletin.

ELSEWHERE in this issue are given some figures showing the present status of street and electric railways in Germany. A recent United States Census Bulletin contains similar statistics for America, some of which are here presented by way of comparison, as well as for their own great instrinsic value.

The bulletin was prepared by Messrs. T. Commerford Martin and E. Dana Durand, special experts, and is issued by Mr. W. M. Steuart, the chief statistician for manufactures. The statistics contained therein cover all street and electric railways in the United States that were in operation during any part of the year ending June 30, 1902. During this period "there were in existence 817 operating electric railway companies and 170 leased companies, making a total of 987 companies. These companies owned or controlled 22,576.99 miles of single track. The par value of the capital stock and funded debt outstanding, as reported, amounted to $2,308,282,099. The average net capital liabilities per mile of single track owned for the companies reporting both factors were $96,287. The total income and expenses of the operating companies amounted to $250,504,627 and $219,907,650, respectively. The companies gave employment on the average during the year to 133,641 wage earners, and paid $80,770,449 in wages. There were 7,128 salaried officials and clerks employed, to whom $7,439,716 was paid in salaries. The roads carried 5,871,957,830 passengers of all kinds."

A number of the street railway companies in existence at the census of 1890 failed to make reports to the Census Office, and, therefore, a comparison of the statistics of the two censuses is, to that extent, defective, exaggerating somewhat the growth which actually took place. From the items as reported, it appears that the single track mileage increased from 8,123 miles in 1890 to 22,577 miles in 1902, or 178 per cent., and the number of fare passengers carried from 2,023,000,000 to 4,810,000,000, or 138 per cent.

"The term 'street and electric railways,' as used in the bulletin, includes all electric railways irrespective of their length or location, and all street railways irrespective of their motive power. At the census of 1890 the railroads that used motive power other than steam were confined almost exclusively to urban districts and were properly classed as street railways, but the application of electricity has enabled these roads to greatly extend their lines in rural districts, and a large proportion of the trackage is now outside the limits of cities, towns or villages. That the use of electric power has been the principal factor in the development of these railways during the past twelve years is shown by the following table, which presents for the years 1890 and 1902, the number of companies and miles of single track in the United States, segregated according to motive power:"

	1902		1890	
Power.	Companies.	Single Track.	Companies.	Single Track.
Electric	747	21,920	126	1,262
Animal	67	259	506	5,662
Cable	26	241	55	488
Steam	9	169	74	711
Total	849	22,589	761	8,123

In this table fractional parts of miles are omitted. The total for 1902 includes 12 miles of track duplicated in reports of different companies, and in the figures for electric roads of that year are included 6 miles operated by compressed air. Of the electric roads, 21,280 miles were single overhead trolley, 23 miles double overhead trolley, 266 miles conduit trolley, 343 miles third rail, and 2½ miles storage battery.

"The length of single track, 22,589 miles, reported for 1902, consists of 16,652 miles of first main track, 5,030 miles of second main track, and 907 miles of sidings and turnouts. Of the total single-track mileage, 21,914 miles, or 97 per cent., were operated by electric power, and 416 miles, or 1.9 per cent., by other mechanical traction, while only 259 miles, or 1.1 per cent. were operated by animal power, as compared with 69.7 per cent. operated in the last way in 1890. Of the total trackage in use by all companies, 84.3 per cent. was owned by the operating companies, and 15.7 per cent. leased. The mileage of track constructed and opened for operation during the year covered by the report, was 1,550 miles, or 6.9 per cent. of the total, but this does not cover all of the track under construction, which it was impracticable to enumerate. For the United States, exclusive of Massachusetts, where this classification was not made, 13,208 miles of single trackage, or 65.8 per cent. of the total, were reported as within urban limits, and 6,856 miles, or 34.2 per cent., as outside of such limits.

"The increase in the trackage is due not only to the establishment of new companies, but very largely to the extension of the lines of established companies. The 'length of line,' as mentioned in the report, means the length of the roadbed, or in the case of a railway lying entirely within city limits, the length of street occupied. In determining the length of single track, switches and sidings are included, and double track is reckoned as two tracks. The increase in the length of line during the period of twelve years amounted to 11,532 miles, or 225 per cent., as compared with an increase of 14,466 miles, or 178 per cent., in the length of single track. Single track roads are characteristic of rural districts, and the fact that the percentage of increase in length of line is greater than in length of single track is due principally to the great development of interurban single track since 1890.

"The average length of line per operating company in 1890 was 7.41 miles as compared with 20.38 miles in 1902, so that in the latter year the average company controlled almost three times the length of line that was operated by the average company in 1890. In 1890 there were only 8 companies operating more than 50 miles of line, and in 1902 the number of such companies had increased to 69. Of this number, 25 companies operated over 100 miles each, with a total length of line of 4,349 miles. Of the total number of companies reported for 1890, 94.9 per cent. operated less than 20 miles of line each, and their combined length of line amounted to 71.5 per cent. of the total in the United States; in 1902 corresponding percentages were 75 and 30.7, respectively. Thus, while there are still a large number of companies that operate less than 20 miles of track the percentage of the total length of line operated by them is not half what it was in 1890.

There were 66,784 cars of all classes reported. The largest number, 3,612, reported for a single company is given for the Boston Elevated Railway Company, of Boston, Mass., which includes cars operated on both surface and elevated tracks. There were 60,290 passenger cars, and 6,494 cars used for express work or other purposes. Of the passenger cars, 32,658 were closed and 24,259 were open. Combination closed and open cars were reported by 105 companies, the total number being 3,134, of which 38.4 per cent. were used by 22 companies in California. There were 239 combination passenger and express cars; 1,114 express, freight or mail cars; 2,860 work and miscellaneous cars; 1,727 snowplow cars and 793 sweeper cars. There were 50,699 cars provided with electric equipment, and as the roads operated entirely or in part by electric power reported a total of 64,618 cars of all classes, the number of trailers on electric roads was about 14,000, and the number having electric equipment was 78.5 per cent. of the total. Of the passenger cars, each traveled, on the average, 18,003 miles and carried 97,395 passengers during the year.

"Steam was used by 540 companies as the primary motive power to generate electric current. The statistics concerning steam power classify the engines according to horse-power. There were, in all, 2,336 engines, with a total horse-power of 1,298,133, or 556 h.p. per engine. Of this number 1,588 engines each were reported as having 500 h.p. or under, with a total horse-power of 420,551, or an average of 265 for each engine. There were 431 engines having a horse-power of over 500 but under 1,000 each, the total horse-power being 297,757, or 691 per engine, and 317 engines having a total horse-power of more than 1,000 each, the total being 579,825 h.p. or 1829 per engine. The Pittsburg Railway Company, of Pittsburg, Pa., reports forty-seven engines, which is the largest number returned by a single company. The greatest amount of steam horse-power, 79.075, is reported by the Interburban Street Railway Company, of New York, N. Y. The greatest number of large engines, i. e., engines having more than 1,000 h.p. each, is reported by the Union Traction Company, of Philadelphia, Pa., which had twenty-one engines with a total of 37,800 h.p., but the Interurban Street Railway Company, of New York, N. Y., with only fifteen engines, reported a horse-power capacity of 78,600, while the Boston Elevated Railway Company, of Boston, Mass., with twenty engines, reported a total of 48,200 h.p.

"There were 159 water-wheels, with horse-power of 49,153, used as the primary power in the generation of electric current. The average horse-power per water-wheel was 309. There were 129 wheels of 500 h.p. or less, twelve of over 500 and under 1,000, and eighteen of 1,000 and under 2,000. Of the total horse-power 34,215, or 69.61 per cent., was reported by sixteen companies in the States of California, Georgia, Maine, Minnesota and New York. The largest plant of this character was shown for the Twin City Rapid Transit Company, of Minneapolis, Minn. This company reported the use of twelve water-wheels, ten of which had 1,000 h.p. each."

The direct-current electric generators numbered 2,861, with a total horse-power of 972,314, the number having a capacity of 1,000 horse-power and over being 209, with an output of 330,456 horse-power. There were 441 alternators, with 231,924 horse-power, those over 1,000 horse-power numbering 58, with a capacity of 133,571 horse-power. In the main stations, storage batteries having an aggregate horse-power of 19,744 were reported, while the storage batteries in sub-stations had a total of 39,249 horse-power.

"Of the 5,871,957,830 passengers carried, 4,809,554,438, or 81.91 per cent., were fare passengers, and 1,062,403,392, or 18.09 per cent., were transfer passengers. The transfer passengers included those using free transfers, also in a few cases those using transfers for which an additional payment was required. There were 4,455 transfer points reported. The average number of fare passengers per mile of single track operated in the United States was 208,600. In preparing this average only the companies from which complete statistics were received are considered. Of the total car mileage, 1,099,256,774, the passenger cars travelled 98.7 per cent., and the freight, mail, express and other cars, 1.3 per cent. The fare passengers per car mile for all companies averaged 4.43."

Some comparative financial summaries are given in the following table, but the totals for 1890 do not include returns from all the companies. The figures are in millions of dollars:

Items.	1902.	1890.
Cost of construction and equipment	$2,168	$380
Capital stock issued	1,316	289
Funded debt outstanding	993	189
Earnings from operation	248	91
Operating expenses	142	62
Percentage operating expenses of earnings	57.5	68.4

It is impossible, in a brief review, to even mention all the interesting features of these statistics, the completeness of which may be gathered from the fact that all the street-railway companies in the United States, with the exception of 22, have furnished complete returns. It is hoped that even these last will supply satisfactory statements in time to be included in the final report now in preparation, which will contain many details not given in the preliminary report, together with a careful analysis, and an elaborate discussion of the development of the modern electric railway system.

STREET AND ELECTRIC RAILWAYS IN GERMANY.

STATISTICS OF THE STREET AND ELECTRIC RAILWAYS IN OPERATION AND UNDER CONSTRUCTION IN THE GERMAN EMPIRE.

Elektrotechnische Zeitschrift.

EVERY year the *Elektrotechnische Zeitschrift* publishes the statistics of electric railways in Germany, and a few extracts from the latest report may be of interest. Figures are given for all the electric railways in public service, including surface roads, elevated railways, and all other kinds, both urban and interurban.

The great majority of the roads have overhead trolley wires of the usual construction. Part of the Königsberg system has double overhead wires, forming outgoing and return circuits. The cities which have conduit roads are Berlin, Charlottenburg, Dresden, and Düsseldorf.

There are combined overhead and accumulator systems in Berlin and several other cities, and in two places, Bremerhaven and Ludwigshafen, the cars are operated by accumulators alone. In Bremerhaven there is a street line with seven motor cars, each of which carries 86 storage battery cells, with a capacity of 300 ampere hours. Connecting Ludwigshafen, Worms, Neustadt and other cities of the Palatinate, there is a standard-gauge railway about 100 miles long, including branches, which was formerly operated by steam, but on which now run large accumulator cars with such trailers as the traffic demands.

The Berlin elevated and underground railway and the newly opened suburban standard-gauge road between Berlin and Gross-Lichterfelde are operated with the third-rail conductor, while the high-speed experimental line from Marienfelde to Zossen is the sole representative of the triphase system. Between Barmen, Elberfeld and Vohwinkel there is the famous suspended railway, where the cars run on a single, overhead rail, and in Barmen there is also an electric rack-railway, running up the side of a hill and continuing on as an ordinary adhesion road into the surrounding country. The road between Frankfort-on-Main and Offenbach has a peculiar overhead conductor, consisting of a slotted tube, in which slides a contact piece.

Almost all the railways have a gauge of either 1 meter or 1.435 meters (4 feet 8½ inches); among the few exceptions are Düsseldorf, with 1.445 meters, and Brunswick, with 1.1 meters.

During the year 1902, electric railways were put in operation in the following cities: Colmar, Cologne, Freiberg in Saxony, Freiburg in Breisgau, Halle-Merseburg, Hamburg-Harburg, Heidelberg and Metz. Large additions to existing lines were made in Berlin, Breslau, Dresden, Hamburg and Upper Silesia. On October 1, 1902, there were electric railways in 125 different cities and districts, compared with 113 the year before. In the early part of 1903, 5 more systems were installed, making a total of about 130 at the present time.

The increase in the length of lines during 1902 was 300 kilometers (186 miles), and the roads since completed and under construction amount to about 400 kilometers (249 miles) more, so that the total length of the electric roads is now about 3,800 kilometers (2,360 miles). The length of single track is about 5,700 kilometers (3,540 miles).

The capacity of the generators which furnish current for electric railways rose from 108,000 kilowatts on October 1, 1901, to 122,000 on October 1, 1902, and since then it has increased about 2,000 kilowatts. so that the total output of traction generators is now about 124,000 kilowatts. Some of these machines are in stations generating current for railway purposes only, while others are in combined light and power stations. Accumulators now play an important part in railway power stations, either as load equalizers, or as a reserve, and their total capacity is now over 30,000 kilowatts, as against 25,500 a year ago. The great and growing importance of electric traction as a means of transportation is shown still more strikingly by the figures for cars, the number of motor cars having increased during the past year from 7,300 to 12,500, and the trailers from 5,000 to 8,000.

In addition to the foregoing technical statistics, some figures concerning the operation and finances of the street railways, taken from the *Zeitschrift für Kleinbahnen*, may be mentioned. According to this journal, there were in Germany, at the end of 1901, 186 street railway lines, including electric and horse railways, with a length of 3,007 kilometers (1,868 miles). During the year 1901, 1,044 million passengers were carried, and the receipts amounted to 108 million marks. A summary of the street railway traffic of the ten largest cities is shown in the following table:

City.	Population.	Passengers, in millions.	Length in miles.
Berlin and suburbs	2,530,000	330	218
Hamburg-Altona and suburbs	870,000	108	92
Munich	500,000	53	30
Leipzig	460,000	65	63
Breslau	420,000	32	27
Dresden	390,000	74	75
Cologne	370,000	31	35
Frankfort-on-Main	290,000	52	31
Hanover, with Linden	290,000	26	105
Nuremberg	260,000	18	16

The average receipts per passenger varied from 8.8 pfennigs (2.1 cents), in Breslau, to 10.9 pfennigs (2.6 cents) in Hamburg. The net receipts of some of the municipal street railways were: Munich, 1,765,903 marks ($420,000); Frankfort, 1,729,440 marks; Düsseldorf, 307,774 marks; Mannheim, 259,543 marks; Cologne, 224,-382 marks; Königsberg, 210,840 marks; Munich-Gladbach, 106,843 marks ($25,000). The dividends of the street railway companies varied from nothing to 19 per cent. Three companies divided more than 10 per cent. among their stockholders; 26 between 5 and 10 per cent.: and 21 between 3 and 5 per cent.

Although the past year in Germany was a very poor one for the electrical industry in general, there was decided activity in the electric railway field, and it is owing to this circumstance that the general economic depression did not have even more serious results for the electrical business. The street railways are operated almost entirely by electricity, and the electrification of the secondary railways is under way.

THE HUDSON RIVER TUNNEL.

THE PRESENT CONDITION OF WORK ON THE ELECTRIC RAILWAY TUNNEL UNDER THE HUDSON BETWEEN JERSEY CITY AND NEW YORK.

The Engineering Record.

ONE of the earliest transportation problems of New York was that of providing means of communication across the Hudson River with the New Jersey shore and thus with all the country lying to the west and south. Canoes, row boats, sailing craft and steam boats have all been used in turn, but even the most modern types of double-deck, screw ferry boats are not fully able to meet the demand for a rapid and unfailing method of transportation which shall be independent of wind and weather, fog and ice. In consequence, therefore, of the inevitable drawbacks of even the best ferry service, many plans have been devised for bridging or tunneling the Hudson. One or more of the bridge schemes seemed in a fair way of accomplishment, when the farsightedness and courageous enterprise of the Pennsylvania Railroad in deciding to drive a tunnel under the river and into the heart of the city put a new aspect on the situation and revived interest in subterranean methods of solving the transfluvial problem.

Nearly thirty years ago a tunnel scheme was successfully promoted and the construction was begun in 1874, according to an article in a recent issue of *The Engineering Record*. The tunnel was to run from the foot of 15th street, Jersey City, to the foot of Morton street, New York, and was to have two tubes. Work was continued intermittently until 1882, when, after constructing about 2,000 feet of the north tube and 550 feet of the south tunnel, the original company suspended operations. An English company was organized to carry on the work, but they also abandoned it in 1891, although not before the north tube had been driven nearly 4,000 feet from the Jersey shore.

"When work was commenced, there were few precedents of such construction, on a large scale under similar conditions; and as the conditions were very difficult, the work was costly and dangerous, it having been reported that over four million dollars were expended upon it. It was originally known as the North River Tunnel, and the work was in charge of some of the first men in this country to use the pneumatic process. A shield was not at first employed and the attempt to excavate the very fine soft silt in a large heading eventually caused a disaster which cost many lives. The excavation was made under pneumatic pressure and the cast-iron lining segments were fitted into position as rapidly as practicable so as to leave the least possible amount of unsupported earth and silt. Great difficulty was found in keeping up the pressure, as the earth was not dense enough to retain the air thoroughly and its escape was immediately followed by an inflow of water. This was always preceded by a hissing sound which gave warning so that the men could usually stop the hole with clay before the water commenced to enter. On one occasion a leak suddenly developed which was so large that it was impossible to stop it with the clay and straw at hand because they were immediately forced through the opening by the air pressure. In this emergency Capt. John Anderson, the superintendent, with great heroism, placed his body in the opening and remained there until his assistants could insert clay between him and the earth and gradually close the dangerous leak. Later on a large leak occurred and before all the men could escape the door of the air-lock became jammed so that it could not be operated and the remainder of the men working there were drowned. These events happened many years ago under the earlier administration, but they are of interest as showing the perils which were met, and the great advance in methods and appliances which have since been made and now prevent the danger of future accidents of a similar nature."

At the time of its abandonment, in 1891, the north tube had been made secure and allowed to gradually fill with water. "In the latter part of 1896 and the early part of 1897, the bondholders took possession and gave instructions to have the tunnel freed of water for the purpose of examining its condition. On completion of this work, it was found that the work previously done, with the exception of some 470 feet, was in a satisfactory condition and re-organization then proceeded, the New York & New Jersey Railroad Company finally being incorporated with abundant capital to carry on and complete the work.

"During this time the tunnel was maintained, regularly pumped and kept in good condition until in April, 1902, orders were given to prepare to proceed with the construction work. The plant which had been installed on the New York side of the river had been entirely removed, the shaft allowed to fill up, the top was covered and it was completely abandoned. At the New Jersey shaft, the existing buildings were of light wooden construction and the machinery installed therein was for the most part out of date and in very bad condition. It was decided to make a complete sweep of all the existing plant and to remodel the whole installation with an entirely new and modern equipment for safe and rapid construction and at the same time to build the plant fireproof so that there might be no danger to the works from fire at the surface buildings.

A steel frame building was erected at the New Jersey end of the tunnel, and divided internally for the various offices and dressing rooms, and to accommodate the machinery installed on the surface.

"The shaft at the west end of the north tunnel is 30 feet in diameter and 65 feet deep. It is lined with brick and is enclosed in the power house where the operating plant is installed. The north tunnel has a clear internal diameter of 18 feet 1¼ inches and an external diameter of 19 feet 5¼ inches. The south tunnel has corresponding diameters of 15 feet 3 inches and 16 feet 7 inches, and both are built with cast-iron linings or shells made with segmental plates flange-bolted together. The north tunnel shell is composed of rings 20¼ inches long, each of them having eleven segments and a key 11 inches long at the crown. The segments have a web 1½ inches thick and flanges on all sides 8 inches deep over all and about 2¼ inches thick at the base. They are slightly tapered and have parallel bearings for steel bolts 1¼ inches in diameter. The inner edges of the flanges have wedge-shaped clearances for packing and the flanges are stiffened by transverse ribs or webs about 10 inches apart and 1 inch thick. Through the center of each segment there is a grout hole 1¼ inches in diameter which is closed with a screwed plug. The weight of one ring, 20¼ inches long, is about 12,765 pounds, which is equivalent to 7,565 pounds per linear foot, the segments thus weighing a little more than 1,100 pounds each. The lining for the south tunnel is composed of similar rings 24 inches long, each made with nine segments and a key and weighing 11,340 pounds, equivalent t● 5,670 pounds per linear foot.

"The principal difficulty in the construction lies in the very soft silt which has to be penetrated, the very thin roof which is left over the tunnel, and in the fact that the surface of the bed rock is so irregular that in some cases the tunnel is partly in rock and partly in silt. No large tunnel has previously been built with a shield working partly in silt anu partly in rock, and the work which is now in progress by this method is consequently of special interest.

"The shield installed by the former management has been overhauled and altered in many respects, and in its present condition is being used for the north tunnel with entire satisfaction. This shield, however, was designed for use only in the Hudson River silt and was not originally adapted for use when rock occurred at the invert and silt over the arch. Construction was therefore suspended after it had been advanced a short distance anu an excavation was made in the front of the shield in which an apron was built. This extended 6 feet in advance of the face of the cutting edge and reached from side to side of the shield itself. It was built of 12-inch I-beams and ¾-inch steel plates riveted solid with the shield itself and heavily stayed. Under it the sides and face of the excavation were heavily timbered and closely poled. The apron permits the advance of the chield in all cases where the rock does n extend 6 feet above the lower part of the cutting edge. The apron thus affords a 6-foot shelter for the men drilling and excavating the rock below it, and, in the chief engineer's opinion, has given absolute satisfaction in its operation.

"The shield measures 19½ feet inside of the tail piece and is advanced with sixteen 8-inch hydraulic jacks. The pressure developed in the jacks corresponds with the amount necessary to push the shield forward, and varies day by day according to the character of the soil. The cast-iron lining plates are assembled in the rear of the shield by a double-acting radial hydraulic erector with hydraulic swivelling gear. The erector is independent of the shield and is moved forward as needed.

"The north tunnel is equipped with a cable hauling system, built in three independent sections which are separated by the air-locks. The first section, 1,575 feet long, reaches from the foot of the shaft to the first air-lock; the second section, 1,660 feet long, reaches from the first to the second air-lock; and the third section extends with a variable length from the second air-lock to the working face. Each section is operated by a special hoisting engine.

"A temporary wooden floor is built

through the tunnel on its horizontal diameter, and on it are laid two 21-inch tracks, about 5 feet apart on centers, which reach from the shaft to the working face. All of the machinery and all the cable, except what lies between the tracks to receive the car grips, is underneath the temporary platform. When the heading has advanced from 10 to 20 feet beyond the end of the cable system, a tension carriage below is moved back a corresponding distance and the movable section of the track and front platform are moved forward on the working platform and secured there ready for continued service, the whole operation being easily and quickly made and not requiring special adjustment. After the heading has advanced 700 feet beyond the point where the cable system was installed, another length of rope can be spliced on the 3,000 feet at first used, and the system continued indefinitely. The ropes are driven at a speed of 300 feet a minute, and the system has a calculated capacity of 300 tons in ten hours, there being about 40 steel cars, each weighing 1,400 pounds and having a capacity of 2,600 pounds.

"In the south tunnel new air-locks have been installed, the required machinery is under contract, and it is expected that the construction of the tunnel will be resumed in September. The shield, which is being built, is of a new design. It is stiffened by vertical and horizontal frames and by transverse diaphragms, and is provided in front with a movable cantilever working platform which may be protruded beyond the cutting edge if necessary. In the rear are arranged the hydraulic jacks, valves and other mechanism necessary for moving the shields and for operating the erector, which is a diametrical arm concentric with the shield and commanded by hydraulic apparatus. It receives the segments, which have special brackets for connection with it, and sets them in place inside the tail of the shield.

"Since the operations have been resumed, work has progressed actively with the one exception of delay caused in changing and altering the shield. Progress in rock and silt on the work recently executed has been between 4 and 5 feet per day of finished tunnel, built unaer exceptionally difficult and hazardous conditions, with 65 feet of water and only 10 feet of soft silt over the crown of the tunnel.

"The authority of the New York Department of Docks has been given to occupy surface over the old shaft at the New York end of the tunnel, for construction purposes. A fireproof steel building, 80 feet square, will be erected for the accommodation for workmen and for the installation of the machinery, similar to that on the New Jersey side. The shafts, however, are different, as the one on the New Jersey side is an open one and the headings are reached through horizontal air-locks in the tunnel, while on the New York side, instead of sinking an open shaft, a closed cassion was sunk and access was had to it through a small steel shaft terminating in a T-shaped air-lock at the bottom. This shaft is too small for the new workings and will be torn out and replaced by a larger one with a T-shaped air-lock above the surface. A hoisting cage will be operated inside this shaft for the removal of the excavated material in cars and for taking supplies into the tunnel. This plant will be used for the construction of that portion of the approaches which is to be lined with cast-iron plates, and from it will be driven the river portions of the tunnel to meet the headings from the New Jersey shaft. A second shield similar to the one described is now under construction and will be operated from this plant.

"The tunnel will have a maximum depth of 102 feet below water level. The distance from the tunnel to river bottom varies from 5 to 65 feet, and the tunnel is driven at a grade of about 2 per cent.," rising in both directions from the middle of the river. An electric railway will run through the tunnel, making connections on the New York side, where there will be a large terminal station, with the Metropolitan Street Railway. At the New Jersey end there will be two approaches, one from the Pavonia ferry of the Erie Railroad, and the other from a point near the Hoboken ferries and the station of the Delaware, Lackawanna & Western Railroad. At these points connections will be made with the electric railway system of Northern New Jersey, an extensive suburban territory being thus placed in direct communication with all parts of Manhattan.

THE ENGINEERING INDEX

"THE ENGINEERING INDEX IS THE KEYSTONE OF APPLIED SCIENCE"

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arch.

Replacing a Suspension Bridge by a Masonry Arch. Brief illustrated description of special work in replacing a highway bridge crossing the Dordogne River at Argental, in France. 700 w. Eng News—July 16, 1903. No. 56747.

Australia.

Pyrmont Bridge, Sydney, Australia. John Plummer. Illustrations, with brief account of the construction work of this bridge, which has a swing span of 223 ft., and twelve side spans, each of 82 ft. 1000 w. Sci Am Sup—July 11, 1903. No. 56661.

Eye-Bars.

Comparison of Eye-Bar Chains with Steel Wire Cables for the Manhattan Bridge. Extracts from a statement by Mr. Lindenthal on the comparative merits of eye-bar chains and steel wire cables for suspension bridges. 1500 w. Eng News—June 25, 1903. No. 56363.

Wire Cables versus Eye-Bar Chains for Suspension Bridges. Wilhelm Hildenbrand. Gives facts and figures favorable to wire cables and criticises the opinions of Mr. Gustav Lindenthal in regard to the Manhattan bridge. 1800 w. Eng Rec —July 4, 1903. No. 56545.

We supply copies of these articles. See page 958.

Laibach.

A Concrete-Steel Three-Hinged Arch Bridge. Illustrations and particulars of the bridge at Laibach, Austria, taken from an article by Prof. J. Melan in the *Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereins*. 1800 w. Eng News—July 16, 1903. No. 56749.

Lattice Trusses.

An Exhibit of Some Curious Lattice Trusses. George N. Linday. Gives illustrated study of miniature trusses made to determine their behavior when loaded. General discussion. 4500 w. Jour W Soc of Engrs—June, 1903. No. 56397 D.

Lift Bridge.

Scherzer Rolling-Lift Plate Girder Bridges. An illustrated detailed description of a recently completed bridge at Bridgeport, Conn., carrying four tracks of the N. Y., N. H. & H. R. R. over the Pequonnock River. 1800 w. Eng Rec—July 11, 1903. No. 56643.

Magdeburg.

The Königsbrücke in Magdeburg (Der Bau der Königsbrücke in Magdeburg). O. Peters. An illustrated description of a large ornamental bridge over the Elbe River, with a steel arch from which the highway is suspended, and masonry towers at the ends. 1 Plate. 3000 w. Serial. 2 Parts. Deutsche Bauzeitung—May 30 and June 6, 1903. No. 56181 each D.

Manhattan Viaduct.

Erecting the Manhattan Valley Viaduct. Brief illustrated account of methods adopted to avoid interrupting traffic in a very busy thoroughfare. 700 w. Ir Age—July 30, 1903. No. 56851.

Minneapolis Viaduct.

Failure of a Steel Viaduct at Minneapolis, Minn. A description of the conditions which existed and the cause of the failure. 450 w. Eng News—June 25, 1903. No. 56362.

Prussian Specifications.

Specifications for the Design of Bridges with Steel Superstructure (Vorschriften für das Entwerfen der Brücken mit Eisernem Ueberbau). The official specifications for steel bridges on Prussian government railways. 5000 w. Zentralblatt d Bauverwaltung—June 20, 1903. No. 56218 B.

Railway Bridges.

Railway Bridges. Alexander Ross. Read at the Engng. Con. of the Inst. of Civ. Engrs. Indicates the difficulties that exist in standardizing railway practice in respect of loads on bridges up to 200-ft. span. 1500 w. Engng—June 19, 1903. No. 56315 A.

Suspension Bridge.

A Semi-Rigid Suspension Bridge over the Rhone, at Vernaison, France (Pont Suspendu Semi-Rigide de Vernaison, Rhône). Ch. Dantin. Illustrated description of a highway suspension bridge, of 232 meters span, with low stiffening trusses, near Lyons. 1 Plate. 1600 w. Génie Civil—July 4, 1903. No. 56917 D.

Suspension Bridge at Vernaison. Illustrates and describes a bridge recently constructed over the Rhone. 700 w. Engr, Lond—July 17, 1903. No. 56816 A.

Transfer Bridge.

A Transfer Bridge with a Span of 400 Meters (Transbordeur de 400 Mètres de Longeur). An illustrated description of a hinged-arch bridge, from which is suspended a car, for transporting passengers and vehicles across the Gironde River, at Bordeaux, France. 1 Plate. 1500 w. Génie Civil—June 20, 1903. No. 56913 D.

Tyne.

New High Level Bridge Over the Tyne. Illustrates and describes a new railway bridge under construction at Newcastle. 1800 w. Transport—July 3, 1903. No. 56559 A.

Uganda.

The American Invasion of Uganda. Joseph M. Rogers. An illustrated account of the twenty-seven American bridges, built on the Uganda Ry. and interesting features of the construction work. Also gives brief review of conditions in this section of Africa, and historical events of interest. 3200 w. Rev of Revs—July, 1903. No. 56349 C.

CANALS, RIVERS AND HARBORS.

Aar River.

The Water Power Development of the Hydro-Electric Plant at Wangen-on-the-Aar, Switzerland (Ueber die Wasserbauten des Elektrizitätswerkes Wangen a. d. Aare, Schweiz). R. Schmick. An illustrated description of the construction of a movable dam, a canal and other work for water power development on the Aar River. Serial. 2 Parts. 3500 w. Deutsche Bauzeitung—June 20 and 27, 1903. No. 56182 each D.

Alps.

The Water Powers on the Northern Slopes of the Alps (Die Wasserkräfte am Nordabhange der Alpen). Dr. Oskar von Miller. An account of the available water powers on the rivers flowing from the northern slopes of the Alps in Switzerland, Austria and particularly, in Bavaria, with maps and tables. 4000 w. Zeitschr d Ver Deutscher Ing—July 11, 1903. No. 56240 D.

Belfast.

Belfast Harbor and Its Development. G. F. L. Giles. Read before the Inst. of Nav. Archts. Maps and description, with information concerning each of the important docks. 2000 w. Engng—July 17, 1903. No. 56821 A.

Buenos Aires.

The Harbor of Buenos Aires and the La Plata River (Der Hafen von Buenos Aires und seine Zukunft im Zusammenhang mit dem La Plata). C. Offermann. A description of the La Plata River and the improvement of the harbor of Buenos Aires, Argentina. Map. Serial. 2 Parts. 7000 w. Zentralblatt d Bauverwaltung—April 15 and 18, 1903. No. 56209 each B.

Canals.

Ship Canals (Seekanäle). Hr. Eger. A general review of the ship canals of the world, both built and projected, with tables of statistics. Serial. 2 Parts. 3500 w. Zentralblatt d Bauverwaltung—May 16 and 20, 1903. No. 56214 each B.

Charles River.

A Study of the Geology of the Charles River Estuary and Boston Harbor, with Special Reference to the Building of the Proposed Dam Across the Tidal Portion of the River. W. O. Crosby. Investigations made to learn how far these channels had their origin in tidal scour, and to learn the character of the ground on which the dam would have to be built. 13000 w. Tech Quar—June, 1903. No. 56387 E.

Core Walls.

Macadam as a Core for Dams and Reservoir Embankments. Editorial on the advantages of this material for the uses named, its cost being less than concrete. 1200 w. Eng News—June 25, 1903. No. 56360.

Corinth.

The Corinthian Canal. Frank W. Jackson. Brief historical account of this undertaking, with discussion of reasons why it has not proved commercially successful. Ill. 1500 w. Sci Am Sup—July 25, 1903. No. 56792.

Dams.

A High Masonry Dam in Germany. Illustrations and brief description of an unusually high dam being built across the small river Urft. 700 w. Eng News—July 16, 1903. No. 56750.

The Great Goose Creek Dam for the Denver Water Supply. An illustrated description of one of the most notable dams in the world, having a height of 231 ft., and, when filled, impounding about 30,000,000,000 gallons of water. 700 w. Sci Am—July 4, 1903. No. 56466.

An Interesting Test of an Unfinished Arch Dam. Describes the Six-Mile Creek Dam of the Ithaca Water-Works Company, and gives a report of the test by a flood before the dam was completed. Ill. 900 w. Eng Rec—July 18, 1903. No. 56737.

The Failure of the Oakford Park and Fort Pitt Dams, Near Jeannette, Pa. Willis Whited. Brief illustrated account of these two disasters. 1000 w. Eng News—July 23, 1903. No. 56843.

Dover.

The New Harbor Works at Dover. Harold J. Shepstone. An illustrated description of this important engineering work on the south coast of England. 1800 w. Sci Am Sup—June 27, 1903. No. 56355.

Dredging.

Dredging in New South Wales. Cecil West Darley. Read at Engng. Con. of the Inst. of Civ. Engrs. On the extensive river improvement that conditions have made necessary and the dredges used. 1200 w. Engng—June, 1903. No. 56318 A.

Dredging, with Special Reference to Rotary Cutters. James Henry Apjohn. Read at Engng. Con. of the Inst. of Civ. Engrs. Describes dredges used for dredging clay. 1000 w. Engng—June 19, 1903. No. 56319 A.

Emscher River.

The Improvement of the Emscher River (Verbesserung der Vorflut im Emschergebiet). Hr. Middeldorf. A paper before a Dortmund mining society, describing the unsatisfactory conditions in the valley of the Emscher, Westphalia, and giving plans for improving the current flow and the sanitary condition of the stream. 2 Plates. 2500 w. Glückauf—June 27, 1903. No. 56294 D.

Erie Canal.

The Erie Canal—Its Past and Future. M. M. Wilner. Gives an account of the proposed enlargement, reviews the past history, and discusses the outlook and New York's industrial position. Ill. 4700 w. Rev of Revs—July, 1903. No. 56-350 C.

Floating Docks.

See Marine and Naval Engineering.

Floods.

The Recent Mississippi Floods and Their Relation to the Levees. T. G. Dabney. Extracts from a manuscript report on the high water of 1903 made to the Mississippi River Commission. 2000 w. Engng News—July 9, 1903. No. 56651.

The Heppner Disaster. John T. Whistler. Copy of a report made to the U. S. Geol. Survey. An account of a destructive storm causing great loss of life and property. 1800 w. Eng News—July 16, 1903. No. 56746.

Foreshores.

Foreshore Protection and Travel of Beaches. William Tregarthen Douglass. Read at the Engng. Con. of the Inst. of Civ. Engrs. Discusses points of importance in sea-defence. 1400 w. Engng—June 19, 1903. No. 56316 A.

Forth-Clyde.

Proposed Forth-Clyde Ship Canal. Information, by David Alan Stevenson, in regard to this proposed deep-water canal across Scotland. Map. 2000 w. U S Cons Repts, No. 1705—July 24, 1903. No. 56798 D.

Hydro-Electric Plants.

See Electrical Engineering, Generating Stations.

India.

Notes on the Ports and Harbors of Peninsular India. Horace Bell. Showing the need for more ports in India, and discussing the difficulties. 3200 w. Jour Soc of Arts—July 17, 1903. No. 56803 A.

Kiel Canal.

The Kaiser Wilhelm Canal and Its Operation (Der Kaiser Wilhelm-Kanal und Seine Bisherigen Betriebsergebnisse). Josef Riedel. An illustrated description of this ship canal between the North Sea and the Baltic, and account of its operation, with statistics of traffic. Tables. 4000 w. Oesterr Wochenschr f d Oeffent Baudienst—July 4, 1903. No. 56268 D.

Needle Dam.

The Reconstruction of a Needle Dam on the Fulda River, Germany (Wiederherstellung eines Nadelwehres an der Fulda). Julius Greve. An illustrated description of repair work on a needle dam built to improve the navigation of the Fulda. 2400 w. Zentralblatt d Bauverwaltung—April 29, 1903. No. 56211 B

Panama Canal.

A Colombian View of the Panama Canal Question. Raul Pérez. A statement of the case. 2500 w. N Am Rev—July, 1903. No. 56351 D.

Sea Wall.

The Galveston Sea Wall. An illustrated description of structures at Galveston, Tex. The concrete wall is protected by a mass of heavy granite rip rap and backed by an earth fill to the level of the top of the wall, and formed into a driveway about 70 ft. wide. 2000 w. Eng Rec—July 4, 1903. No. 56543.

Water Hyacinth.

Destroying the Water Hyacinth by a New Chemical Process. Describes a method now being tried for ridding southern rivers of this troublesome growth, which seems to give promise of success. 900 w. Sci Am—July 4, 1903. No. 56463.

CONSTRUCTION.

Concrete Building.

The Erection of a Tall Concrete Office Building. An illustrated description of the construction of the Ingalls building, in Cincinnati. 4000 w. Eng Rec—July 18, 1903. No. 56734.

Concrete Coping.

Some Hints on Making Concrete Coping. Indicates how good looking and yet inexpensive concrete coping may be made. 800 w. Eng News—July 9, 1903. No. 56653.

Drilling.

Experience in Diamond Drill Work on the Deep Waterways Survey. Information from the Report of the Board of Engrs. on Deep Waterways, giving reliable data of costs of drilling 25 holes each averaging about 100 ft. deep. 2000 w. Eng News—July 23, 1903. No. 56845.

Fireproof Construction.

Building Construction from a Fire Brigade Officer's Point of View. Arthur Pordage. Read before the International Fire Congress. Showing that construction called "fireproof" often adds to the danger, and discussing accepted theories in regard to fireproof materials. Short discussion. 4000 w. Builder—July 11, 1903. No. 56673 A.

How to Make Existing London Buildings More Fire-Resisting. Max Clarke. Read before the International Fire Congress. Deals with constructional details. 2700 w. Builder—July 11, 1903. No. 56674 A.

Framework.

Contribution to the Theory of Framework Structures (Beitrag zur Theorie des Räumlichen Fachwerks). Prof. Th. Landsberg. A graphical and mathematical discussion of the stresses in frameworks in three dimensions. Serial. Part 1. 2000 w. Zentralblatt d Bauverwaltung—May 6, 1903. No. 56212 B.

Hudson Tunnel.

The Hudson River Tunnel. Reviews the history of this undertaking from its commencement in 1874, and gives an illustrated account of the preparations to complete the work. The tunnel will cross from the foot of 15th St., Jersey City, to the foot of Morton St., N. Y. 3800 w. Eng Rec—July 25, 1903. No. 56839.

Pile Driving.

Why the Nasmyth Steam Hammer Has Not Displaced the Friction-Clutch Pile Driver. Editorial showing how small a part of the working day is spent in actual driving, and suggesting needed improvements in methods of handling the piles, etc., and other details to secure economy. 1000 w. Eng News—July 2, 1903. No. 56415.

Piling.

The Calculation of Piling (Zur Berechnung der Bohlwerke). Prof. H. Engels.

An illustrated description of experiments with wooden stakes driven into sand, and a mathematical discussion of the results as applied to piling and similar work. 2500 w. Zentralblatt d Bauverwaltung—June 3, 1903. No. 56216 B.

Reinforced Concrete.

A Five Story Machine Shop of Reinforced Concrete. Illustrates and describes the interesting building, and method of erection, now in progress in Philadelphia, for Mr. Hugo Bilgram. 900 w. Am Mach—July 2, 1903. No. 56419.

Roads.

The United States Road Material Laboratory. Logan Waller Page and Allerton S. Cushman. Read before the Am. Soc. for Test. Materials. Historic review of road material tests; the present article is devoted principally to the methods in use in France. Ill. 2300 w. Eng Rec—July 25, 1903. Serial. 1st part. No. 56840.

Tarred Roads in America. Information concerning tar-macadam roads as shown in Ontario and from other sources, with cost, work of construction, etc. Ill. 2800 w. Automobile—July 11, 1903. No. 56607.

Notes on Some Moderate Cost Roads. William G. Raymond. Describes roads recently constructed, near Troy, N. Y., giving the contract prices for building. Ill. 1500 w. Eng Rec—July 18, 1903. No. 56736.

Simplon Tunnel.

The Construction of the Simplon Tunnel (Der Bau des Simplontunnels). C. J. Wagner. A general review of the progress of work on this great tunnel through the Alps, from Jan. 1, 1901, to Jan. 1, 1903, with illustrations and tables. Serial. 2 Parts. 1 Plate. 9000 w. Oesterr Wochenschr f d Oeffent Baudienst—June 13 and 20, 1903. No. 56266 each D.

Steel Structures.

Specifications for Material and Workmanship for Steel Structures. T. L. Condron. Gives diagram, showing the variations in the physical and chemical requirements, and submits specifications based upon steel having an average tensile strength of 62,000 lbs. per sq. in., with discussion. 12800 w. Jour W Soc of Engrs—June, 1903. No. 56396 D.

Temporary Buildings.

Minimizing the Risk of Fire in Temporary Buildings. T. W. Aldwinckle. Read at meeting of the Incor. Assn. of Munic. & Co. Engrs. Describes the ordinary temporary building, and considers what steps may be taken to minimize the fire risk. 3000 w. Builder—July 11, 1903. No. 56675 A.

MATERIALS.

Asphalt.

Asphalt Rock in Kentucky. William E. Burk. Locates and describes these deposits. Map. 1200 w. Eng & Min Jour—June 27, 1903. No. 56442.

Bitumen.

The Testing of Bitumen for Paving Purposes. A. W. Dow. Abstract of a paper read before the Am. Soc. for Test. Materials. Briefly describes the construction of one class of asphalt pavement, discussing its properties, and gives tests devised by the writer for the determination of these properties. 2500 w. Eng Rec—July 11, 1903. No. 56644.

Cement.

A Study of the Constitution of Hydraulic Cements (Etude sur la Constitution des Ciments Hydrauliques). S. B. Newberry and Melville M. Smith. Chemical and physical examinations of Portland and other cements. 5000 w. Bull Soc d'Encou—May 31, 1903. No. 56929 G.

Portland Cement in Germany. Reports the production as far exceeding the demand, and gives information in regard to consumption, etc. 700 w. U S Cons Repts, No. 1691—July 8, 1903. No. 56498 D.

Portland Cement Manufacture: the Raw Materials. Edwin C. Eckel. Discusses the character of the raw materials available, and the proportions of the mixture. 1600 w. Munic Engng—July, 1903. No. 56385 C.

Soundness Tests of Portland Cement. W. P. Taylor. Read before the Am. Soc. of Testing Materials. An illustrated article reviewing methods of testing for determining soundness, and explaining some of the causes of unsoundness. 3000 w. Eng News—July 23, 1903. No. 56844.

Testing the Soundness of Cement. Frederick W. Taylor, and Sanford E. Thompson. Considers the methods advocated by the Committee of the Am. Soc. of Civ. Engrs., and outlines several other methods. 3000 w. Am Arch't—July 18, 1903. No. 56744.

Cement Works.

The Plant of the Hudson Portland Cement Co., at Hudson, N. Y. An illustrated detailed description of a plant using limestone and shale or clay as raw materials, now being built. The rotary kiln dry process. 2200 w. Eng News—July 23, 1903. No. 56841.

The Works of the St. Louis Portland Cement Company, Prospect Hill, Mo. John E. Conzelman. An illustrated detailed description of a modern plant for the manufacture of Portland cement by the dry process. 3500 w. Eng Rec—July 11, 1903. No. 56642.

Clay.

Effect of Fineness of Grain on the Fusibility of Clay. Heinrich Ries. A brief report of experiments showing that the size of grain exerts a marked influence on the point of fusion. 700 w. Trans Am Inst Min Engrs—Feb., 1903. No. 56704.

Concrete.

The Merits of Rubble Concrete. Editorial discussion of the advantages and disadvantages of concrete, concluding that except in places where cut stone would be used, concrete has no economic advantage over stone masonry. Shows the value of rubble concrete when great strength is required. 1200 w. Eng News—July 16, 1903. No. 56748.

Reinforced Concrete.

The Theory of Reinforced-Concrete Construction (Theorie der Betoneisen-Konstruktionen). E. Mörsch. An address before the "Deutscher Betonverein," giving a general discussion of concrete-iron construction and its principles. Diagrams. 5000 w. Serial. 3 Parts. Deutsche Bauzeitung—April 25, May 2 and 6, 1903. No. 56180 each D.

Applications of the Hennebique System of Reinforced-Concrete Construction in Hydraulic Works (Anwendung von Betoneisen (System Hennebique) im Wasserbau). A. v. Horn. An illustrated description of quay walls and structures in and under water, built of reinforced concrete. 1 Plate. 2000 w. Oesterr Wochenschr f d Oeffent Baudienst—June 27, 1903. No. 56267 D.

A Graphostatical Investigation of Compound Bodies of Concrete and Iron (Graphostatische Untersuchung der Verbundkörper aus Beton und Eisen). Robert Bortsch. A theoretical graphical discussion of the stresses in steel-concrete structures. 1 Plate. 2000 w. Oesterr Wochenschr f d Oeffent Baudienst—July 4, 1903. No. 56269 D.

Timber Seasoning.

See Railway Engineering, Permanent Way.

MEASUREMENT.

Precise Level.

The New Coast and Geodetic Survey Precise Level: A Possible Successor of the Wye Level. John F. Hayford. An illustrated description of the instrument and its manipulation, with report of its use in actual service. 3500 w. Eng News—July 2, 1903. No. 56413.

Soundings.

Rapid River Soundings on the Survey of the Danube. Brief description of a method used by the Austrian government engineers. 900 w. Eng News—July 16, 1903. No. 56752.

Stereoscopic Measurer.

A Stereoscopic Instrument for Measuring Distances in Hydrographical Surveys (Ueber Stromsondierungen). Karl Grünhut. An illustrated description of a binocular instrument by which the distance to an object can be readily determined from a boat or any other place. 1500 w. Oesterr Wochenschr f d Oeffent Baudienst—July 4, 1903. No. 56270 D.

Surveying Instruments.

Note Concerning an Old Instrument for Finding Distances, Exhibiting the Oldest Known Form of the Transit-Theodolite Principle. H. D. Hoskold. Illustrations and information concerning early devices for the object under consideration. 4000 w. Trans Am Inst of Min Engrs—Oct., 1903. No. 56768 C.

MUNICIPAL.

Civil Engineers.

The Civil Engineer and His Work in Small Cities. J. S. Humphrey. Considers the varied demands made upon a city civil engineer. 2500 w. Pro Indiana Engng Soc—1903. No. 56772 D.

Dresden Exposition.

The German Municipal Exposition in Dresden (Die Deutsche Städte-Ausstellung in Dresden). J. O. Knoke. A general review of this exhibition of engineering and other features of modern cities. 4000 w. Zeitschr d Ver Deutscher Ing—July 4, 1903. No. 56238 D.

The German Municipal Exposition at Dresden (Deutsche Städteausstellung in Dresden). An illustrated account of an exhibition of the various engineering and other features of modern cities. Serial. Part 1. 700 w. Zentralblatt d Bauverwaltung—June 6, 1903. No. 56217 B.

Fire-Engine House.

The New Barracks of the Paris Firemen (La Nouvelle Caserne de Sapeurs Pompiers). M. Marchand. A well-illustrated description of engine-house, barracks and apparatus for fire fighting in Paris. 1 Plate. 2500 w. Génie Civil—June 6, 1903. No. 56909 D.

New Orleans Drainage.

See Electrical Engineering, Power Applications.

Pavements.

Improved Streets and Their Repairs. W. F. Raymond. Discusses repairs to asphalt, brick, granite block, wooden block, bituminous macadam, and pavements generally. 2200 w. Munic Engng—July, 1903. No. 56386 C.

Refuse Disposal.

The Use of Refuse in Agriculture (Ueber die Landwirtschaftliche Verwertung des Müll). Dr. Wilsing. A discussion of the use of refuse and garbage for manuring purposes. 3000 w. Gesundheits-Ingenieur—May 20, 1903. No. 56198 B.

River Pollution.

On the Pollution of Our Rivers. Charles Milnes Gaskell. Reviews the history of the rivers of Great Britain, and the action against river pollution; what has been accomplished, and what remains to be done. 6300 w. Nineteenth Cent—July, 1903. No. 56671 D.

Stream Pollution and Remedial Policy. M. O. Leighton. Considers the natural pollution due to the land being occupied, the household sewage and refuse, and the wastes from industries, discussing the limitations which should obtain in all requirements even while aiming at improvements. 3000 w. Pro Indiana Engng Soc —1903. No. 56773 D.

Sewerage.

The Sewerage System of the Old Part of Magdeburg (Die Kanalisation der Altstadt von Magdeburg). An illustrated description of the new system of sewers installed in this German city, on the Elbe River. Serial. Part 1. 2800 w. Zentralblatt d Bauverwaltung—March 21, 1903. No. 56207 B.

Bacterial Treatment of Water and Sewage Up to Date. Dr. Percy Frankland. Read before the Engng. Con. of the Inst. of Civ. Engrs. Introductory to a discussion. Names the points most desirable to consider; the relative merits of different methods, contact beds, effluents, storm water, etc. 1800 w. Engr, Lond—July 10, 1903. No. 56696 A.

The Composition of Sewage in Relation to Problems of Disposal. George W. Fuller. Gives a review of the progress in this field, the prevailing methods of disposal, and especially the dilution method and modes of treatment preparatory to filtration. 9800 w. Tech Quar—June, 1903. No. 56389 E.

Northwestern Avenue Sewer, Indianapolis. Walter Buehler. An illustrated detailed description of interesting construction work. 3500 w. Pro Indiana Engng Soc—1903. No. 56771 D.

Sidewalks.

Sidewalk Building and Sidewalk Grades in Small Towns. Ernest McCullough. An account of experience of a small town, with report of the work as finally carried out by the writer. 2300 w. Eng News—July 9, 1903. No. 56652.

Stray Currents.

See Street and Electric Railways.

Trackways.

Trackways for Streets (Strassengleise). A. H. Weicht. Illustrated descriptions of flat steel trackways, of various sections, for street traffic. 4000 w. Zeitschr d Mitteleuropäischen Motorwagen-Ver—No. 12, 1903. No. 56228 D.

WATER SUPPLY.

Cincinnati.

Notes on Progress of Cincinnati's New Water Works. C. N. Miller. An illustrated report of the progress made on these extensive new works. 2400 w. Eng Rec—July 4, 1903. No. 56542.

High Pressure.

Philadelphia's High Pressure Fire Pipe Line. An illustrated account of this recently installed line to protect the "congested district," with report of its trial. 1000 w. Sci Am—July 11, 1903. No. 56657.

India.

Famines and Their Results. Reports results of some of the irrigation works, giving illustrations of reservoirs, and especially an account of Kathiawar. 1200 w. Engr, Lond—July 17, 1903. No. 56-812 A.

Ozone.

The Sterilization of Water by Means of Ozone (Stérilisation de l'Eau par l'Ozone). Dr. Ed. Imbeaux. General illustrated historical and descriptive review. Serial. 2 Parts. 4500 w. Rev Technique—June 25 and July 10, 1903. No. 56925 each D.

Shrewsbury, Eng.

Shrewsbury Water Supply. A brief illustrated account of a recently installed pumping plant of novel description. 1100 w. Engr, Lond—June 19, 1903. No. 56-328 A.

Sterilization.

The Sterilization of Water (Die Wassersterilisation). Dr. Schüder. A general review of water purification and methods of removing injurious bacteria. 4000 w. Gesundheits-Ingenieur—June 10, 1903. No. 56199 B.

Syracuse, N. Y.

Syracuse Water Works. A review of their history from 1841 to 1902. Ill. 3000 w. Fire & Water—June 27 & July 4, 1903. Serial. 2 Parts. No. 56364.

Tall Buildings.

Water Supply of Tall Buildings. George W. Nistle. Especially considers conditions at Chicago, suggesting the drilling of wells far enough to get uncontaminated water. Discusses methods of delivery and piping, the arrangements for ice cold water, and hot water. 2800 w. Dom Engng—June 25, 1903. No. 56367 C.

COMMUNICATION.

Automatic Telephony.

The Mix & Genest Automatic Telephone Sub-Station System (Neue Automatische Fernsprechnebenstellensysteme Mix & Genest, Berlin). Dr. L. Rellstab. A paper before the Elektrotechnischer Verein, giving an illustrated description of an automatic system for private branch telephone exchanges, with discussion. Serial. 2 Parts. 3000 w. Elektrotech Zeitschr—July 2 and 9, 1903. No. 56-255 each B.

An Automatic Telephone Exchange for Chicago. R. E. Sack. Illustrates and describes the interesting exchange of the Illinois Telephone & Telegraph Co. 3000 w. Elec Wld & Engr—July 4, 1903. No. 56540.

The Faller Mechanical Telephone Operator. Frank C. Perkins. An illustrated description of the interesting invention of Ernest A. Faller, with its recent improvements, and data of interest. 2500 w. Elec Engr, Lond—June 19, 1903. No. 56336 A.

Exchange.

The Telephone Exchange of the Manmattan Railway Company. Brief illustrated description of a private exchange for intercommunication with its numerous stations, yards and terminals, having no outside connections. 1000 w. Elec Rev, N. Y.—June 27, 1903. No. 56444.

Utica Home Telephone Company's Exchange. F. L. Martin. An illustrated detailed description of construction work consisting of an office building, a complete underground system, cable and aerial system, including the installation of the central office and subscriber's sub-station equipment. 2800 w. Elec Wld & Engr—July 18, 1903. No. 56738.

Pacific Cable.

Completion of the First American Pacific Cable. Map showing the route from San Francisco to Manila, with information of interest concerning this recently completed work. 1400 w. Elec Wld & Engr—July 11, 1903. No. 56641.

Selector.

The Rodary Selective Signaling System on the Paris-Lyons-Mediterranean Railway (Applications du Rappel Bréguet-Rodary aux Communications Télégraphiques et Téléphoniques sur les Chemins de Fer de P. L. M.). M. Rodary. Illustrated description of a selective call applied to telegraph and telephone stations on a railway. 2000 w. Rev Gén Chemins de Fer—June, 1903. No. 56-941 H.

Space Telegraphy.

Hertzian Wave Telegraphy. Dr. Fleming's second paper, dealing with transmitting arrangements and transmitters. Ill. 3200 w. Sci Am Sup—July 11, 1903. No. 56664.

Hertzian Wave Telegraphy. Dr. Fleming's third paper, dealing with receiving arrangements and receivers. Ill. 4200 w. Sci Am Sup—July 18, 1903. No. 56678.

Hertzian Wave Telegraphy. Dr. Fleming's fourth paper discussing the question of wireless telegraphy in view of the problem of privacy. Ill. 3700 w. Sci Am Sup—July 25, 1903. No. 58793.

Electrical Syntony and Wireless Telegraphy. Nevil Maskelyne. An account of the interference in connection with the experimental lecture of Prof. Fleming at the Royal Institution. Also gives reprint of letters from Dr. Fleming and the author as published in the London *Times*. 4000 w. Elect'n, Lond—June 19, 1903. No. 56338 A.

The Lodge-Muirhead System of Wireless Telegraphy. Maurice Solomon. Illustrates some of the instruments and discusses features of this system. 2500 w. Nature—July 16, 1903. No. 56830 A.

Wireless Telegraphy. Edmund A. N. Pochin. Read before the Engng. Con. of the Inst. of Civ. Engrs. Brief consideration of syntonic and optical methods of securing isolation. General discussion. 4500 w. Elec Engr, Lond—June 26, 1903. No. 56478 A.

Wireless Telegraph Systems at Martinique. Emile Guarini. An illustrated article concerning the wireless station recently established to give the island means of communication in case of dangerous manifestations of Mont Pelée. 1000 w. Elec, N. Y.—July 22, 1903. No. 56745.

Telephony.

The Telephone and the Technical School. J. C. Kelsey. Read before the convention of the Ind. Tel. Assn. of the U. S. Urging that a telephone course that will be of benefit to the industry be established in the universities. 1500 w. Elec Rev, N. Y.—July 11, 1903. No. 56632.

Telephotography.

The Transmission of Photographs by Telegraph (Sur la Transmission de Photographies à l'Aide d'un Fil Télégraphique). M. Korn. An illustrated description of a telephotographic apparatus, including a selenium resistance at the transmitter and a vacuum tube discharge, varied by the line current, at the receiver.

We supply copies of these articles. See page 958.

400 w. Comptes Rendus—May 18, 1903. No. 56946 D.

Tuned Transmitter.

The Production of Alternating Currents by a Microphone Transmitter (Ueber die Erregung von Wellenströmen durch eine Mikrophonanordnung). R. v. Lieben and E. Reisz. A description of a method of exciting alternating currents of a definite frequency by meaus of a small iron plate attached to a microphone and in inductive relation to the microphone current. Diagrams. 600 w. Elektrotech Zeitschr—June 25, 1903. No. 56-250 B.

DISTRIBUTION.

Boosters.

On Boosters. G. Stephens. Considers the conditions under which batteries are worked, and the methods of connecting the booster, etc. Ill. 2000 w. Elec Engr, Lond—July 3, 1903. No. 56566 A.

Conduits.

Moisture in Conduits. W. H. F. Murdock. Calls attention to some of the difficulties in wiring, especially in damp places. 1200 w. Elect'n, Lond—July 10, 1903. No. 56721 A.

Local Power.

Local Distribution of Transmitted Power. George C. Holberton. Read at Con. of Pacific C. Elec. Trans. Assn. Discusses how the best results may be obtained. 2700 w. Jour of Elec—July, 1903. No. 56614 C.

Mains.

Systems of Mains Laying. F. H. Davies. A detailed consideration of subways, conduit systems, pipe systems, cables laid direct in the earth, and solid systems. 3500 w. Elec Engr, Lond—June 19, 1903. No. 56335 A.

Monocyclic Current.

Monocyclic Current from Three-Phase System. F. Hardie Jeannin. Describes the situation and the scheme resorted to by the writer. Ill. 1000 w. Am Elect'n —July, 1903. No. 56637.

Safety Devices.

Notes on the Construction of Electric Safety Devices for Weak-Current Installations (Beitrag zur Konstruktion Elektrischer Sicherungen für Schwachstromanlagen). Hans Carl Steidle. A description, with diagrams, of lightning protectors, fuses and other protective devices for telephone and telegraph plants. 2500 w. Elektrotech Zeitschr—July 2, 1903. No. 56254 B.

Single-Phase.

Transmission and Distribution by Single-Phase Alternating Current. E. W. Monkhouse. Showing the advantages of this system. Short general discussion. 2000 w. Elect'n, Lond—June 26, 1903. No. 56483 A.

Submarine Cables.

Some Points Relating to Submarine Electric Power Cables. G. U. G. Holman. Refers to lessons taught by interruptions of service on the submarine power cable belonging to the Canadian Electric Light Co., which is laid on the bed of the St. Lawrence River. 1600 w. Can Engr—July, 1903. No. 56506.

Sub-Stations.

Notes on Sub-Station Practice. On the proper location, design and operation of sub-stations for railway service. 2500 w. St Ry Jour—July 4, 1903. No. 56-533 D.

Switchgears.

The Design of Extra High Tension Switchgears. W. E. Warrilow. Begins an illustrated description of recent designs showing the developments which have resulted from experience. 1700 w. Elec Engr, Lond—July 3, 1903. Serial. 1st Part. No. 56567 A.

ELECTRO-CHEMISTRY.

Accumulators.

Manufacture of Electrical Accumulators. A copy of the draft regulations which have been issued under the Factory and Workshop Act, 1901, in England. 1500 w. Elec Rev, Lond—June 26, 1903. No. 56482 A.

The Principles and Care of Accumulators. Horace M. Wyatt. Considers the ways in which an accumulator may be damaged, and why they affect the plates. Ill. 2000 w. Autocar—June 20, 1903. No. 56346 A.

See also Electrical Engineering, Generating Stations; and Streets and Electric Railways.

Chlorine Smelting.

Chlorine Smelting, with Electrolysis. James Swinburne. A discussion of a new process covering a wide domain in metallurgy comparing with present processes, and considering cost, etc. 2800 w. Elect'n, Lond—July 10, 1903. Serial. 1st Part. No. 56720 A.

Diamonds.

The Production of Diamonds in the Electric Furnace. C. L. Durand. Describes the work of Prof. Henri Moissan in this field, illustrating the furnace used. 2500 w. Elec Rev, N. Y.—June 27, 1903. No. 56443.

Dielectrics.

The Heat of a Change in Connection with Changes in Dielectric Constants and in Volumes. C. L. Speyers. Gives an account of experimental investigations with a study of results. 4500 w. Am Jour of Sci—July, 1903. No. 56381 D.

Electrolysis.

The Present Position of the Theory of Electrolysis. W. C. Dampier Whetham. Read before the Faraday Society. Reviews the early investigations made which establish the convective view of electrolysis, gives arguments supporting the dissociation theory, and an experimental study of the phenomena of electrolysis and the osmotic properties of electrolysis. 7500 w. Elektrochem & Met —July 1, 1903. No. 56568 A.

Fluorine.

Production of Fluorine in Moissan's Electrolytic Apparatus. Illustrates the electrolytic apparatus used, explaining how the gas is obtained in a pure state. 800 w. Sci Am—July 4, 1903. No. 56464.

Garuti Process.

The Garuti Process of Generating Oxygen and Hydrogen. Emile Guarini. An illustrated description of the apparatus of Dr. Pompes Garuti for the electrolytic production of oxygen and hydrogen. 1200 w. Sci Am Sup—June 27, 1903. No. 56356.

Lead Refining.

Electrolytic Lead-Refining. Anson G. Betts. Describes a successful process using a solution of lead-fluosilicate, containing an excess of fluosilicic acid, as an electrolyte. Ill. 3000 w. Trans Am Inst of Min Engrs—Feb., 1903. No. 56761.

Nitric Acid.

The Production of Nitric Acid by Means of Electric Discharges (Sur la Production de l'Acide Nitrique par Décharges Electriques). J. de Kowalski. A description of a process for extracting nitrogen, which then forms nitric acid, from the atmosphere by means of electric discharges, a discussion of the theory, and a review of other similar processes. 2500 w. Bull Soc Internat d Electriciens—June, 1903. No. 56939 H.

ELECTRO-PHYSICS.

Crookes Tube.

On the Properties of the Field Surrounding a Crookes Tube. Arthur W. Goodspeed. Reprinted from *Pro. Am. Phil. Soc.* An account of investigations suggested by radiographic records below the plate. 2800 w. Sci Am Sup—June 27, 1903. No. 56357.

Electrode Voltage.

Electrode Voltage of Electrode Potential. Woolsey McA. Johnson. An explanation of this term is given. 1800 w. Electro-Chem Ind—July, 1903. No. 56-512 C.

Matter.

Modern Views on Matter. Sir Oliver Lodge. The Romanes Lecture, delivered in the Sheldonian Theatre, Oxford, June 12, 1903. Contains much information of interest to students of electro-physics. 7000 w. Pop Sci M—Aug., 1903. No. 56822 C.

Modern Views on Matter. The Realization of a Dream. Sir William Crookes. Address before the Congress of Applied Chemistry, at Berlin. Discussing the latest views as to the constitution of matter. 6000 w. Sci Am Sup—July 11, 1903. No. 56663.

Radiography.

The New Radiations—Cathode Rays and Roentgen Rays. A. Dastre. Translated from the *Revue des Deux Mondes* for the Smithsonian Report. An examination of recent views on the radioactivity of matter. 8000 w. Sci Am Sup —July 4, 1903. No. 56467.

Stereoscopic Radiography (La Radioscopie Stéréoscopique). P. Villard. An illustrated study of Röntgen-ray apparatus, particularly those for securing stereoscopic views. 3000 w. Bull Soc d'Encour—June 30, 1903. No. 56931 G.

Radium and Its Lessons. Sir Oliver Lodge. Summarizes the facts established thus far in regard to this substance, discussing how they are to be accounted for, and giving suggestions for investigations. 3500 w. Nineteenth Cent—July, 1903. No. 56670 D.

Radium and Its Recent Development. From the French of Prof. Cyr. Wattiez, in *L'Industrie Textile.* A review of what is known of this substance and its peculiar properties. 2800 w. Sci Am Sup—July 25, 1903. No. 56794.

The Properties of Radium. Abstract of a lecture at the Royal Inst., London, by M. Curie, the discoverer of radium. 1800 w. Mech Engr—June 27, 1903. No. 56-474 A.

Rays Emitted by a Welsbach Burner, which Pass Through Metals, Wood, etc. (Sur l'Existence, dans les Radiations Emises par un Bec Auer, de Rayons Traversant les Metaux, le Bois, etc.). R. Blondlot. Account of experiments, with radiographs. 700 w. Comptes Rendus—May 11, 1903. No. 56943 D.

GENERATING STATIONS.

Aar River.

See Civil Engineering, Canals, Rivers and Harbors.

Accumulators.

Storage Batteries on Electric Railways. Howard S. Knowlton. Explains the construction and installation of the storage battery, and its functions in the power house or on the line with "booster" service. 3000 w. The Engineering Magazine —Aug., 1903. No. 56903 B.

See also Street and Electric Railways.

Alternators.

Alternating Current Generators and Synchronous Motors. George T. Hanchett. Explains the construction of these machines. Ill. 2000 w. Cent Sta—July, 1903. No. 56605.

Asynchronous Machinery.

Compounded Asynchronous Machinery. G. Hooghwinkel. Briefly explains the difference between synchronous and asynchronous machines, and states the advantages of a compounded and self-exciting asynchronous alternator, describing the struction. 1700 w. Elec Rev, Lond—July 17, 1903. Serial. 1st Part. No. 56806 A.

British Statistics.

Some Statistics of Electricity Supply. J. P. Smith. A review of the progress of the last seven or eight years, giving statistics, and favoring municipal undertakings, claiming they show lower capital expenditure, lower working costs, and lower tariffs. Also discussion. 7500 w. Elect'n, Lond—July 17, 1903. No. 56808 A.

Caspian Oil Wells.

Power Transmission Plant of the Apscheron Electric Co., of Baku (Kraftübertragungsanlage der Apscheroner Elektrizitäts-Gesellschaft Baku). A description of a three-phase central station and power transmission plant for boring and operating oil-wells on the Apscheron peninsula, near Baku, on the Caspian Sea. 1600 w. Elektrotech Rundschau—July 15, 1903. No. 56206 D.

Condensing Plant.

See Mechanical Engineering, Steam Engineering.

Design.

The Design of Electric Stations (Ueber die Ausführung von Elektricitätswerken). E. Wikander. A paper on the general design and planning of electric stations, their location, size, arrangement, etc. 2500 w. Elektrotech Zeitschr—July 2, 1903. No. 56253 B.

Direct Current.

The Experimental Investigation of Direct-Current Dynamos (Beitrag zur Experimentellen Untersuchung von Gleichstrommaschinen). E. Arnold. Paper before the Verband Deutscher Elektrotechniker, giving an account, with diagrams and tables, of experiments and tests with direct-current dynamos at the Karlsruhe Technical High School. 7000 w. Elektrotech Zeitschr—June 18, 1903. No. 56246 B.

Discussion.

Central Station Development. Discussion of papers dealing with different combinations in the system of distribution, by H. A. Lardner, Philip Torchio, and Peter Junkersfeld. 22000 w. Trans Am Inst of Elec Engrs—May, 1903. No. 56354 D.

Dresden.

See Mechanical Engineering, Steam Engineering.

Factory Plant.

Electrical and Steam Equipment of a Hardware Factory. W. G. Viall. An illustrated description of a lighting and power plant in New Britain, Conn. 1200 w. Am Elect'n—July, 1903. No. 56633.

Frictional Losses.

The Separation of the Frictional Losses in Electric Machines (Die Trennung der Reibungsverluste bei Elektrischen Maschinen). Dr. Leo Finzi. A description of methods for determining the air friction and the bearings friction of dynamos and motors. Diagrams. 800 w. Elektrotech Zeitschr—July 9, 1903. No. 56-258 B.

Heyland Generator.

On Induction Machines and a New Type of Polyphase Generator. A. C. Eborall. An account of a new type of polyphase generator designed by Alexander Heyland, with remarks on its development. 2700 w. Elect'n, Lond—July 3, 1903. Serial. 1st Part. No. 56569 A.

Hydro-Electric.

The Hydro-Electric Plants of Vouvry and Sault Ste. Marie (Die Elektrizitätswerke Vouvry und Sault Ste. Marie). Kurt Meyer. An illustrated description of a plant operating under a 950-meter head near the Lake of Geneva, Switzerland, and of the Sault Ste. Marie plant in Michigan. 6000 w. Zeitschr d Ver Deutscher Ing—June 27, 1903. No. 56234 D.

Electric Power from the Hudson. Alton D. Adams. Illustrates and describes this important development at Spier Falls, which will supply electric light, power and traction in Albany, Troy, Schenectady, and many other places. 1600 w. Elec Wld & Engr—June 27, 1903. No. 56445.

The Spier Falls Dam and Power Plant of the Hudson River Water Power Company. George E. Howe. A full description, with illustrations, of this great engineering work and its construction. Power will be furnished to Albany, Troy and other cities and towns. 4800 w. Eng Rec—June 27, 1903. No. 56448.

Hydraulic Developments as Related to Electric Installations. William B. Jackson. On the necessity of considering the actual conditions of flow before deciding upon the development, with illustrated description of methods. General discussion. 11000 w. Jour W Soc of Engrs—June, 1903. No. 56399 D.

Losses.

Loss by Electric Lighting Companies Through Poor Meters and Transformers. Information furnished by the Westinghouse Company in regard to a case where great loss was detected due to these causes. 1200 w. Eng News—June 25, 1903. No. 56359.

Manchester, Eng.

The New Electricity Works of the Manchester Corporation. An illustrated detailed description of the largest electric power distribution undertaking in Great Britain. 4000 w. Elec Rev, Lond—June 26, 1903. Serial. 1st Part. No. 56480 A.

Niagara Falls.

Electricity at Niagara Falls. An illustrated description of power house No. 2, and its equipment. 2500 w. Engr, Lond—June 26, 1903. No. 56496 A.

Olean, N. Y.

Power Stations of the Olean, N. Y., Street Ry. Brief illustrated description of the Olean and the new Ceres generating plants, using natural gas as fuel. 1000 w. Steam Engng—July 10, 1903. No. 56-616.

Operation.

Electrical Operation in Central Stations. Howard W. Leitch. Describes the method of operating a station designed on the three-phase system. 3000 w. Power—July, 1903. No. 56409 C.

Parallel Operation.

The Parallel Operation of Alternating-Current Machines (Ueber den Parallelbetrieb der Wechselstrommaschinen). H. Görges. A paper before the Verband Deutscher Elektrotechniker, giving a general discussion of the operation of alternating current generators in parallel. Illustrations. 4000 w. Elektrotech Zeitschr—July 16, 1903. No. 56259 B.

Poplar Works.

Poplar Electricity Works. An illustrated detailed description of these works, with map of the district. 6800 w. Elec Engr, Lond—June 19, 1903. No. 56334 A.

Railway Power Stations.

Central Stations of Electric Tramway Systems. Charles Thonet. A discussion and technical information regarding the maintenance, consumption and efficiency of the different parts of a generating station installation; the cost of the electrical energy measured at the switchboard when using steam, power gas, and hydraulic power. 7000 w. Bul Internat Ry Cong—June, 1903. No. 56401 E.

Tramway Power-House Equipment. E. Kilburn Scott. A series of notes and specifications on electric tramway power equipment. 4800 w. Tram & Ry Wld—July 9, 1903. Serial. 1st Part. No. 56691 B.

The Boston & Worcester Street Railway Power Plant. H. D. Jackson. An illustrated description of the plant in South Framingham, Mass., which represents the latest developments in steam and electrical progress. 1400 w. Engr, U S A—July 1, 1903. No. 56546 C.

Rand.

The Rand Central Electric Works. Brief illustrated description of the largest central power station now at work in the British South Africa colonies. 2200 w. Elec Rev, Lond—July 10, 1903. No. 56-715 A.

Rates.

The Question of Charges for Electric Current (Zur Tariffrage der Elektricitätswerke). Max Schwabach. A discussion of the cost of supplying current from electric stations and the proper system of fixing tariffs. Diagrams, 1600 w. June 25, 1903. No. 56249 B.

St. Louis Fair.

The Temporary Power Station at the World's Fair, St. Louis, Mo. An illustrated description of the machines installed in a temporary station, in order to furnish electrical energy for the dedication ceremonies. 2300 w. Elec Engr, Lond—July 10, 1903. No. 56713 A.

LIGHTING.

Arc Lamps.

Some Notes on Alternating and Direct Current Arcs. P. C. Butte. Read at Con. of Pacific Coast Elec. Trans. Assn. Discusses the action, the relative illumination, the character of illumination, favoring alternating-current enclosed arc, especially for interior illumination. 1700 w. Jour of Elec—July, 1903. No. 56-612 C.

Blue-Printing.

Electric Blue-Print Making. George J. Jones. An illustrated description of the blue-print making machine, in which the electric light is used. 700 w. Sci Am—July 18, 1903. No. 56677.

Mercury Vapor.

The Mercury Vapor Lamp (Die Quecksilber-Dampflampe). Arthur Libesny. An illustrated paper, giving a historical review and description of mercury vapor electric lamps, including the Cooper-Hewitt. Serial. Part 1. 2000 w. Zeitschr f Elektrotech—July 19, 1903. No. 56265 D.

New Forms.

Some Undeveloped Possibilities in the Electric Lighting Field. J. Wright. On new forms of arc and incandescent lamps considered in relation to their possible future development. 2800 w. Page's Mag—July, 1903. No. 56596 B.

Train Lighting.

Electric Lighting of Corridor Trains on the Prussian State Railways. Mr. Wichert, at a meeting of the German Inst. of Mech. Engrs. on April 22, 1903. Translated from *Glaser's Annalen*. The system chosen was that with engine and dynamos fixed on the locomotive and a battery fitted to each carriage. Ill. 8500 w. Bul Internat Ry Cong—June, 1903. No. 56400 E.

MEASUREMENT.

Compass Indicator.

The Indication of Compass Positions at a Distance (Fernübertragung von Kompassstellungen). A description of a method, based on the Wheatstone bridge principle, of indicating the position of a ship's compass at any distance. Diagrams. 700 w. Elektrotech Rundschau—July 1, 1903. No. 56204 D.

Conductivity.

The Electrical Conductivity of Copper. Rollo Appleyard. A study of Matthiessen's standard 100 per cent. conductivity copper, the errors due to density, the resistance of the foot grain, etc., aiming at the attainment of a precise quantity. 2200 w. Elec Rev, Lond—June 19, 1903. Serial. 1st Part. No. 56337 A.

Dynamo-Regulation.

Dynamo-Regulation Testing. F. C. Caldwell. Describes how to make a regulation test. Ill. 2000 w. Engr, U S A—July 1, 1903. No. 56548 C.

Hot-Wire Meter.

Hot-Wire Wattmeter (Hitzdraht-Wattmeter). R. Bauch. A paper before the Verband Deutscher Elektrotechniker, discussing the theory of the hot-wire wattmeter and giving an account of experimental work. Diagrams. 4000 w. Elektrotech Zeitschr—July 9, 1903. No. 56257 B.

Inductance.

Self-Induction Standards and Measurements (Ueber Selbstinduktionsnormale und die Messung von Selbstinduktionen). Dr. E. Orlich. A paper before the Elektrotechnischer Verein, giving an illustrated description of the methods used at the Reichsanstalt, Charlottenburg, for measuring inductances. 4500 w. Elektrotech Zeitschr—June 25, 1903. No. 56251 B.

Induction Meters.

Improvements in Electric Meters Constructed on Ferraris's Principle (Neuerungen an Motorelektricitätszählern nach Ferraris-Princip). J. Busch. A paper before the Verband Deutscher Elektrotechniker, giving an illustrated description of induction-motor watt-hour and other electric meters. 1400 w. Elektrotech Zeitschr—July 2, 1903. No. 56252 B.

Motor Testing.

Brake Horse Power and Efficiency of a Small Motor. J. L. Dickson. A description of a method of measurement used for various loads. 300 w. Elec Wld & Engr—July 18, 1903. No. 56739.

Pyrometer.

An Optical Thermo-Electric Pyrometer (Lunette Pyrométrique à Réticule Thermo-Electrique). Ch. Férv. An illustrated description of a pyrometer, consisting of a telescope containing a thermo-electric couple, which is directed toward the hot body or to an opening in the furnace whose temperature is to be measured. 1500 w. Génie Civil—May 30, 1903. No. 56906 D.

Three-Phase.

A Note on Three-Phase Power Measurement. F. A. Fish. Describes a method used by the writer based on the principle of increasing the angle between the current in the pressure coil and that in the series coil of the watt meter. 1200 w. Elec Wld & Engr—June 27, 1903. No. 56-446.

Water Gauge.

An Electric Water Gauge (Ueber Elektrische Wasserstandsfernmelder). Karl Busse. An illustrated description of an electric apparatus for recording, at any distance, the level of water in a reservoir, tank, etc. 800 w. Elektrizität—May 2, 1903. No. 56201 C.

POWER APPLICATIONS.

Caspian Oil Wells.

See Electrical Engineering, Generating Stations.

Crane.

A Four-Ton Electric Crane (Elektrisch Betriebener Portalkran von 4,000 kg. Tragkraft). H. Koll. An illustrated description of a jib crane carried on a traveling bridge running on tracks, used for loading and unloading in Mannheim harbor, on the Rhine. 1200 w. Zeitschr d Ver Deutscher Ing—June 20, 1903. No. 56232 D.

Electric Crane Experiences. A. D. Williams. Discusses the care and operation, repairs, accidents, etc. 1300 w. Am Mach—July 23, 1903. No. 56777.

Dock Equipments.

The Modern Equipment of Docks, with Special Reference to Hydraulic and Electric Appliances. Walter Pitt. Read before the Engng. Con. of the Inst. of Civ. Engrs. Also abstract of discussion. Advocates the substitution of electric for hydraulic power transmission and compares the relative costs. 2000 w. Elect'n, Lond—July 3, 1903. No. 56571 A.

Electric Driving.

Electric Driving (Applications de l'Electricité à la Distribution de la Force Motrice dans les Ateliers et les Diverses Exploitations Industrielles). E. de Marchena. A general review of electric driving in factories and shops and discussion of different systems. 16000 w. Mem Soc Ing Civils de France—May, 1903. No. 56-936 G.

Electrically Driven Turret Lathe. Illustrated description of an arrangement that enables a motor having a moderate speed variation to be attached direct to the lathe by gearing, and without the intervention of a cone pulley or similar speed-changing device. 1100 w. Engr, Lond—July 3, 1903. No. 56586 A.

Motor-Driven Machine Tools. An illustrated article showing the latest practice in applying individual drives to shapers. 1500 w. Am Engr & R R Jour—July, 1903. No. 56627 C.

Some Experiences with Electrically Driven Printing Machinery. An account of difficulties arising in electrically-driven printing works in London, and the cause and remedy. 1800 w. Elec Engr, Lond —June 26, 1903. No. 56477 A.

Furnace Charging.

See Mining and Metallurgy, Iron and Steel.

Heyland Motor.

The Heyland Induction Motor. A. S. M'Allister. A study of this invention explaining how the provision of an exciting current in the rotor winding takes the place of the usual primary exciting current. Ill. 3000 w. Am Elect'n—July, 1903. No. 56634.

Mines.

Electric Power Appliances in the Mines of Europe. Emile Guarini. An extensively illustrated review of current practive on the Continent. The first part deals with surface plant, generating stations, lighting, and signaling. Serial. 3500 w. The Engineering Magazine—Aug., 1903. No. 56299 B.

Continuous and Alternatng Currents Applied to Mining. Ellis H. Cropper. Lecture delivered before the Nat. Assn. of Colliery Mgrs. Deals with electricity applied to mining, considering the two systems of electrical transmission and distribution of power. 4400 w. Ir & Coal Trds Rev—July 17, 1903. No. 56823 A.

Pumping.

Electrical Equipment of the New Orleans Drainage System. William Mayo Venable. Illustrated description of pumping stations driven by electric power. A very large equipment of three-phase machinery. 1200 w. Elec Rev, N. Y.—July 4, 1903. No. 56522.

Railway Motors.

Railway Motors with Compound Winding (Bahnmotoren mit Kompoundwickelung). H. M. Hobart. An illustrated account of tests made on Johnson-Lundell electric railway motors with compound winding and two commutators. 1 Plate. 1500 w. Zeitschr f Elektrotech—June 28, 1903. No. 56263 D.

See also Street and Electric Railways.

Repulsion Motor.

The Repulsion Motor. Notes from an article by M. Marius Latour, recently published in the *Elektrotechnische Zeitschrift.* Gives a diagrammatic sketch of repulsion motor with distributed stator windings, explaining the theory. 1300 w. Elect'n, Lond—July 10, 1903. No. 56718 A.

A New Single-Phase Motor (Nouveau Matériel à Courant Alternatif Simple). Marius Latour and M. Gratzmuller. The theory of a new single-phase alternating current motor for railway work, and illustrated description of one and results of tests. 3000 w. Bull Soc Internat d Electriciens—June, 1903. No. 56938 H.

Rolling Mills.

The Electric Driving of Reversing Trains of Rolls (Der Elektrische Antrieb von Reversier-Walzenstrassen). Carl Ilgner. An illustrated discussion of electric driving for rolling mills, and account of experiments with an electric mine hoist. 1400 w. Stahl u Eisen—July 1, 1903. No. 56278 D.

Silk Weaving.

Silk Weaving at St. Etienne. Daniel Bellet. An account of the latest improvements by the addition of electric motors for driving the looms in the homes. Ill. 3000 w. Trac & Trans—June, 1903. No. 56305 E.

Single-Phase Motors.

A New Single-Phase Motor (Ein Neuer Einphasenmotor). L. Schüler. An illustrated description of a single-phase alternating-current motor working on the rotary-field and the repulsion principle, with a commutator. 2500 w. Elektrotech Zeitschr—July 16, 1903. No. 56260 B.

Single-Phase Motors on Multi-Phase Plants. H. A. Bullard. Read at Con. of Pacific Coast Elec. Trans. Assn. Explaining its value in polyphase plants, and describing the Wagner single-phase motor and its operation. 1800 w. Jour of Elec —July, 1903. No. 56610 C.

Single-Phase Motors as a Means of Increasing Station Earnings. An explanation of the ways the single-phase alternating current motor tends to the development of economic production. 2000 w. Can Engr—July, 1903. Serial. 1st Part. No. 56508.

Speed Control.

Relative Advantages of Electrical and Mechanical Methods of Variable Speed Control for General Power Service. William Cooper. Read at Convention of Nat. Elec. Lgt. Assn. Discusses the advantages and disadvantages of both systems. 5500 w. Am Elect'n—July, 1903. No. 56635.

Turntable.

New Electric Turntable in Germany. Illustrations showing an electric turntable of interest, with brief notes. 200 w. U S Cons Repts, No. 1706—July 25, 1903 No. 56802 D.

Variable-Speed Motors.

A Direct-Current Electric Motor Whose Speed Can Be Widely Varied (Gleichstrom-Elektromotoren mit in Weiten Grenzen Veränderlichen Tourenzahlen). F. Müller. An illustrated description of a motor with auxiliary winding on the armature creating a counter e. m. f. This winding is in sections which can be cut in and out. 1000 w. Elektrotech Rundschau—April 1, 1903. No. 56203 D.

Variable-Speed Motors and Their Relation to New Shop Methods. Robert T. E. Lozier. Considers the steps which have made for progress in the application of electric motors to machine driving, and the effect of individually applied motors on efficiency and output of shops. 3000 w. Can Engr—July, 1903. No. 56505.

TRANSMISSION.

Composite System.

Composite System of Electrical Transmission and Distribution. Frederick Bedell. Read before the Cleveland Electric Club. Shows some of the ways this system is used for transmission and distribution, pointing out its advantages. 1600 w. Elec Wld & Engr—July 4, 1903. No. 56541.

India.

Electric Power and Transmission in India. An interesting account of the large transmission plant recently completed in Mysore, and used for working the Kolar gold mines, 92 miles distant. Refers to some peculiar problems due to the region. 1800 w. U S Cons Repts, No. 1703—July 22, 1903. No. 56733 D.

Electrical Conditions in India. Arthur C. Hobble. States present conditions, explaining why electrical engineering projects have not kept pace with other engineering enterprises, and gives a brief account of the "Cauvery Power Scheme," which furnishes power for the Kolar gold fields. 1200 w. Elec Rev, N. Y.—July 25, 1903. No. 56834.

Long Distance.

Electric Railway Service as Supplied by Long Distance Power Transmission. Allen H. Babcock. Read at Con. of the Pacific Coast Elec. Trans. Assn. A brief review of the present situation and future outlook, especially on the Pacific Coast. 1800 w. Jour of Elec—July, 1903. No. 56613 C.

The Arrangement and Control of Long-Distance Transmission Lines. E. W. Cowan and L. Andrews. Abstract of paper read before the Manchester Soc. of the Inst. of Elec. Engrs. A discussion of the systems used and present practice. 3800 w. Elect'n, Lond—July 10, 1903. Serial. 1st Part. No. 56719 A.

Pacific Coast.

A Coming Problem for the Pacific Coast Engineer. W. F. Lamme. Read at Con. of Pacific Coast Elec. Trans. Assn. States the advantages of 3,000 alternations instead of 7,200, and the problem is how to change from high to low. 700 w. Jour of Elec—July, 1903. No. 56611 C.

Three-Phase.

A Three-Phase Power Transmission Plant Using High-Tension Motors. Frank C. Perkins. Illustrates and describes an interesting plant in Germany built by the Oerlikon Works. 1600 w. Elec Rev, N. Y.—July 25, 1903. No. 56836.

Transformers.

High-Tension Transformers. J. W. Farley. Describes the transformers of the Shawinigan Water & Power Co. as typical of the latest and best engineering practice in the design of high tension apparatus. 2600 w. Can Engr—July, 1903. Serial. 1st Part. No. 56507.

Vancouver.

Electrical Transmission at Vancouver. An illustrated article describing the hydro-electric transmission plant of the Vancouver Power Co., which will be capable ultimately of delivering 30,000 horsepower. 2400 w. B C Min Rec—July, 1903. No. 56606 B.

MISCELLANY.

Agriculture.

Electricity in the Service of Agriculture (Die Elektrizität im Dienste der Landwirtschaft). Hr. Budérus. An address before the Landwirtschaftlicher Verein at Frankfurt-on-the-Oder, giving a general review of the applications of electricity to agriculture. Serial. 2 Parts. 3000 w. Elektrotech Rundschau—July 1 and 15, 1903. No. 56205 each D.

Balata.

Notes on Balata. H. L. Terry. Remarks on its origin, collection, and employment. 1700 w. Elect'n, Lond—July 10, 1903. No. 56717 A.

Education.

Electrical Engineering Instruction at Columbia University. George F. Sever. Reviews the work in electricity at this university, and gives a chart showing the technical entrance requirements, the course of four years' study, etc. 1600 w. Elec Wld & Engr—June 27, 1903. No. 56447.

The Training of the High Tension Engineer. P. M. Lincoln. Read at the convention of the Can. Elec. Assn. On the relations which should exist between the colleges and outside work. Also discussion. 5800 w. Can Elec News—July, 1903. No. 56801.

Electrical Inspector's Report.

Report of the Electrical Inspector of Factories and Workshops. G. S. Ram. The first report to the Home Office, suggesting improvements tending to safety in working, and calling attention to the variety of methods in use and absence of standard practice. 5500 w. Elect'n, Lond —July 3, 1903. No. 56572 A.

Electric Shocks.

Electric Shocks. Archibald Wilson. Showing that the conditions are extremely improbable under which accidental contact with electric wires can result in dangerous shock. 3500 w. Cassier's Mag—July, 1903. No. 56602 B.

Firestream Conductivity.

The Danger to Firemen When Directing a Stream of Water on Live Wires (Was Ist Ueber die Gefährdung der Feuerwehr beim Anspritzen Stromdurchflossener Drähte zu Sagen). Friedr. Heinicke. An account of experiments which determined the electromotive force between earth and the nozzle of a hose from which a stream of water played on wires carrying high and low tension polyphase and direct currents. Tables. 1500 w. Elektrotech Zeitschr—June 18, 1903. No. 56247 B.

Igniter.

A New Magneto-Electric Igniter (Neuer Magnetelektrischer Zündapparat mit Ueberspringenden Funken). An illustrated description of an igniting apparatus for internal-combustion engines, in which a magneto is wound so as to give a particularly good spark. 1200 w. Elektrizität—May 2, 1903. No. 56202 C.

The Goodson Igniter. Hugh Dolnar. States the advantages of electric ignition, describes the two present methods of producing the spark, and gives illustrated description of the invention named. 2000 w. Autocar—June 27, 1903. No. 56470 A.

Lightning.

Necessary Practical Safeguards Against Fires Caused by Lightning. Alfred Hands. Abstract of a paper read before the Fire Prevention Congress, England. Explains the force of lightning and discusses points necessary to protect buildings. 2200 w. Elect'n, Lond—July 17, 1903. No. 56807 A.

Shipboard.

Uses of Electricity on Board Ship. J. W. Kellogg. Reviews this development since 1880, when the first plant was put into operation, describing modern plants. The present series of articles considers only the uses for lighting and power. Ill. 3700 w. Marine Engng—July, 1903. Serial. 1st Part. No. 56424 C.

United States.

A Traveler's Impressions of the United States (Reiseeindrücke aus den Vereinigten Staaten). Dr. F. Niethammer. A paper before the Elektrotechnischer Verein of Vienna, giving an illustrated general account of electrical engineering in America. Serial. 3 Parts. 10000 w. Zeitschr f Elektrotech—July 5, 12 and 19, 1903. No. 56264 each D.

Welding.

Improvements in Electric Track Welding. George E. Walsh. Describes the process of welding under the present system. 1500 w. Elec Rev, N. Y.—July 25, 1903. No. 56835.

GAS WORKS ENGINEERING

Acetylene.

Acetylene Stored and Transported in Safety. John S. Seymour. Describes a system for the safe transportation and storage of acetylene in tanks of special equipment, explaining the principle, and giving information of interest. 6500 w. Jour Fr Inst—July, 1903. No. 56391 D.

Town Lighting by Acetylene. Augustine Davis. Considers it more economical and of better quality than by gas or electricity. 1500 w. Munic Jour & Engr —July, 1903. No. 56435 C.

Bury, Eng.

From Siding to Coke-Store at the Bury Gas-Works. An inquiry into the cost of labor with machine-worked horizontal retorts. Ill. 2800 w. Jour Gas Lgt—June 30, 1903. No. 56563 A.

Carbonizing.

The Settle-Padfield Carbonizing Process. Illustrates and describes a bench of these vertical retorts under construction at Exeter, giving particulars of the apparatus and the special features of the invention. Reports test. 3000 w. Jour Gas Lgt—June 23, 1903. No. 56402 A.

Coke-Handling.

Coke-Handling in French Gas Works. Illustrates and describes the very complete plant installed by the Compagnie Parisienne d'Eclairage and de Chauffage par le Gaz, which includes a number of electrically driven machines for breaking, screening and drying the coke. 2000 w. Engng—July 17, 1903. No. 56819 A.

Cost of Gas.

Cost of Municipal vs. Private Gas. Alton D. Adams. Claims that the methods of operating private gas plants are expensive and that municipal plants are run more economically, and can therefore furnish cheaper gas. 1500 w. Munic Jour & Engr—July, 1903. No. 56434 C.

Gas Producers.

Some Recent Forms of Gas Producer. Prof. A. H. Sexton. Illustrates and describes some forms of producer suitable for the production of ordinary producer gas. 1800 w. Prac Engr—July 3, 1903. No. 56565 A.

Gas Testing.

Gas and Gas Testing. H. Leicester Greville. A brief comparison of new with old methods of testing, with comments on recent papers and discussions, and suggestions. 2000 w. Jour Gas Lgt—July 14, 1903. No. 56786 A.

Incandescent Lighting.

New Apparatus for Incandescent Gas Lighting (Les Nouveaux Appareils d'Eclairage au Gaz par Incandescence). H. Guérin. Illustrated descriptions of various high pressure and medium pressure lamps. 2500 w. Génie Civil—June 27, 1903. No. 56916 D.

Intensified Lighting.

High-Pressure Gas Lighting in Lace Factories. Report of W. J. A. Butterfield of investigations made of the hygienic aspect of the question. Ill. 3300 w. Jour Gas Lgt—June 23, 1903. No. 56-403 A.

Mantles.

Lighting Power with Incandescent Mantles. M. Sainte-Claire Deville, before the International Photometry Com. at Zurich. Describes the method used at the Paris gas-works for finding the highest maximum illuminating power per unit of volume used per hour, and suggests a method relying upon heating values. 1500 w. Gas Wld—July 11, 1903. No. 56712 A.

Photometry.

Photometry Up to Date. A discussion of means of ascertaining the illuminating power as applied to English methods and gas undertakings. 2200 w. Jour Gas Lgt—July 14, 1903. No. 56785 A.

I. An Improved Photometer for Testing the Illuminating Values of Ordinary and High-Power Welsbach Burners. Charles Carpenter and J. W. Helps. II. Photometry of Incandescent Burners. U. Della Cassa and M. Böhm. Two short papers describing methods. 1500 w. Gas Wld—July 4, 1903. No. 56562 A.

Power Gas.

Commercial Gases for Power Purposes. Alexander M. Gow. General information concerning the use of gas in gas engines. The constituents of commercial gases, the utilization of blast furnace gases, etc., are discussed. 10000 w. Pro Engrs Soc of W Penn—May, 1903. No. 56856 D.

Retorts.

Construction and Working of Modern Retort Settings. The first of a series of articles aiming to assist those whose opportunities have been limited. They will consider the theoretical side of the question and the practical adaptations of the principles. Ill. 1100 w. Gas Wld—June 27, 1903. Serial. 1st Part. No. 56471 A.

A Comparison Between the First Cost of Inclined and Horizontal Retorts. M. Frère. Read before the Société Technique du Gaz at Toulon. 1500 w. Jour Gas Lgt—July 14, 1903. No. 56789 A.

An American Arrangement of Vertical Retort. Illustrations and portion of patent specifications of an invention by Charles F. Dieterich, issued about twenty years ago, and having features similar to the Bueb system. 1500 w. Jour Gas Lgt —July 14, 1903. No. 56787 A.

Shrewsbury, Eng.

The Old and the New at Shrewsbury. An illustrated article describing extensive alterations and enlargements. 6300 w. Jour Gas Lgt—July 7, 1903. No. 56687 A.

Sulphur Recovery.

The Claus Sulphur-Recovery Process at Granton. From the report of Mr. R. Forbes Carpenter, in regard to experiments made, giving results and conclusions. 1800 w. Jour Gas Lgt—June 30, 1903. No. 56564 A.

United Kingdom.

Something About Gas Works in the United Kingdom. Frederic Egner. Information in regard to the gas undertakings of England, Scotland, and Ireland abstracted from parliamentary papers. 1500 w. Am Gas Lgt Jour—July 27, 1903. Serial. 1st Part. No. 56829.

Wood Gas.

Motive Power from Wood (Les Forces Motrices dans les Régions sans Eau et sans Charbon, et en Particulier aux Colonies). A. Lombard. An illustrated description of the Riché wood distillation process, and of the use of wood gas in engines, with views of several plants in French colonies and other parts of the world. 3000 w. Rev Technique—May 25, 1903. No. 56921 D.

INDUSTRIAL ECONOMY

Apprenticeship.

Apprenticeship in Engineering Training. John Dewar Cormack. Read before the Engng. Con. of the Inst. of Civ. Engrs. The discussion is confined to the training of youths destined for responsible positions, as employers, manufacturers, consulting engineers, etc. Also general discussion. 8000 w. Engng—June 26, 1903. No. 56487 A.

The Apprenticeship System at Brown & Sharpe's. William A. Viall. Read at meeting of Nat. Mach. Tool Bldrs. Assn. Explains the system in the shop named, with general remarks. 1800 w. Ir Age —July 2, 1903. No. 56422.

British Trade.

British Trade and the Central European Railways. A study of the influence of the various railway tunnels in Europe upon commerce. Map. 5700 w. Trac & Trans—July, 1903. No. 56722 E.

Imperial Policy and Free Trade. Three articles, by Sir Robert Giffen, Edward Dicey, and Benjamin Kidd, discussing this subject and Mr. Chamberlain's policy. 25900 w. Nineteenth Cent—July, 1903. No. 56668 D.

Imperial Trade and Tariffs. Benjamin Taylor. A discussion of Mr. Chamberlain's views on imperial reciprocity. 4400 w. Page's Mag—July, 1903. No. 56-597 B.

China.

Notes on China (Notes sur la Chine). F. Sibel. An illustrated account of navigation on the Yang-tse-Kiang, and of building and other industries in China. Serial. 3 Parts. 5500 w. Rev Technique—May 25, June 10 and 25, 1903. No. 56923 each D.

Consulting Engineers.

The Consulting Engineer. Dr. Alexander B. W. Kennedy. An inaugural address at the City and Guilds Cent. Tech. College. On the duties and work of the engineer. 5500 w. Arch't, Lond—July 10, 1903. No. 56672 A.

Cyanide.

The Position of the Cyanide Industry. George E. Beilby. Read at Berlin meeting of the International Cong. of Applied Chemistry. Gives the leading events in the history of this industry, both as relating to consumption and production. 3800 w. Jour Gas Lgt—July 7, 1903. No. 56688 A.

Dalny.

The Building of Dalny. Information of interest concerning this Manchurian commercial seaport, its population, industries, railway and steamship service, etc. 3000 w. U S Cons Repts, No. 1708—July 28, 1903. No. 56825 D.

Education.

The Reform in Mathematical Education. An account of the present position of the new method of teaching mathematics to young engineers in England. 3700 w. Engng—June 19, 1903. No. 56309 A.

Industrial Schools in Germany. A report on technical education in Germany. 2500 w. U S Cons Repts, No. 1704—July 23, 1903. No. 56757 D.

Engineering Problems.

Some Unsolved Problems in Engineering. W. H. Maw. "James Forrest" lecture before the Inst. of Civ. Engrs. Considers the economical generation and distribution of power, steam engines, internal combusiton engines, etc.; constructional engineering and the materials employed; cutting tools, etc. 11000 w. Engng—June 26, 1903. No. 56490 A.

The James Forrest Lecture. W. H. Maw. A review of this lecture, with extracts. Deals with heat engines, fatigue of metals and other problems. 2500 w. Engr, Lond—June 19, 1903. No. 56327 A.

Factories.

The Decentralization of Factories. T. C. Elder and Herbert J. Scoble. Gives a presentation of existing conditions and discusses the "Garden City" scheme proposed by Mr. Ebenezer Howard, and the "Industrial Redistribution" pamphlet, by W. L. Magden, with special reference to England. 6700 w. Trac & Trans—June, 1903. Serial. 1st Part. No. 56302 E.

India.

The Industrial Regeneration of India. John Wallace. A statement of present industrial conditions, the methods of manufacture, machinery used, habits of the people. etc., discussing the question of technical education. 6500 w. Cassier's Mag—July, 1903. No. 56600 B.

Industrial Efficiency.

The Promotion of Industrial Efficiency and National Prosperity. III. The Future, and Trades-Union Hostility. John B. C. Kershaw. Discusses the attitude of organised labour toward the newer wage systems and answers the objections the trades union leaders make to the present industrial philosophy as held by employers. Serial. 3rd Part. 2500 w. The Engineering Magazine—Aug., 1903. No. 56908 B.

Labour.

Capital and Labour Harmony. Andrew Carnegie. Reprint of a portion of the

We supply copies of these articles. See page 958.

presidential address before the Iron and Steel Inst. Deals with the methods adopted by the Carnegie Steel Company, and of the United States Steel Corporation, in which partnership and profit-sharing were carried to a far-reaching extent. 7000 w. Cassier's Mag—July, 1903. No. 56598 B.

The Anti-Boycott Movement. Daniel Davenport. Read before the Central Supply Assn. Describes the purpose of the Anti-Boycott Association. 1200 w. Ir Age—July 16, 1903. No. 56682.

Manufactures.

The Census of Manufactures of 1900. Charles E. Monroe. Reviews the history of census taking in the United States, especially discussing the methods of obtaining statistics in regard to manufactories, the defects of the system, and the effects. 7000 w. Jour Fr Inst—July, 1903. Serial. 1st Part. No. 56392 D.

Municipal Trading.

Municipal Trading and Local Rates. Robert Donald. A criticism of an article in the April number, by Hon. Robert P. Porter. 4000 w. Trac & Trans—June, 1903. No. 56300 E.

Osaka Exhibition.

The Osaka Exhibition, Japan. Editorial review of the exhibits and of the portents which they suggest. Chiefly devoted to the machinery section. 2700 w. Engng—July 10, 1903. No. 56706 A.

Philippines.

Military Engineering and Civil Opportunities in the Philippines. Captain William W. Harts. An illustrated account of what has been done by the army of occupation, with some interesting particulars of methods, and an estimate of the work to be accomplished by civil engineers under the civil administration of the islands. 1300 w. Illustrated. The Engineering Magazine—Aug., 1903. No. 56901 B.

The Labor Question in the Philippines. Edwin Maxey. A discussion of the industrial education of the native Filipino. 2000 w. Gunton's Mag—July, 1903. No. 56390.

Piece-Work.

A Remodeled Piece-Work System. John H. Van Yorx, Jr. A practical working description of a plan designed to give a maximum of the necessary detailed information with a minimum of clerical work by any of the shop employees. Illustrated with fac-similes of all the forms used. 4000 w. The Engineering Magazine—Aug., 1903. No. 56902 B.

South Africa.

South African Business. F. J. Frank. Considers some of the mistakes which have been made and which should be avoided, and the opportunities for manufacturers. 2500 w. Mines & Min—July, 1903. No. 56539 C.

Workmen's Insurance.

Workmen's Insurance in Germany (Die Deutsche Arbeiter-Versicherung). Fr. Pichler. Paper before the Technischer Verein of Baltimore, giving an account of the system of workmen's insurance instituted by the German government, in which both employer and employee contribute to the fund. Diagrams. 3000 w Technologist—July, 1903. No. 56106.

MARINE AND NAVAL ENGINEERING

American Shipbuilders.

Suggestions to American Shipbuilders. Remarks on the lack of system in specifications accepted by builders, and the advantage of standard specifications. 1400 w. Marine Engng—July, 1903. No. 56430 C.

Armor.

The Theory and Practice of Armor-Attack. Describes the effect produced by capped and uncapped shot. 1500 w. Engr, Lond—July 17, 1903. No. 56810 A.

Auxiliary Machinery.

The Auxiliary Machinery of Steam Vessels. Jasper E. Cooper. Two articles dealing with this subject. The present considers turning and reversing engines, air and circulating pumps, condensers, feed pumps, and feed heaters. Ill. 6500 w. Cassier's Mag—July, 1903. Serial. 1st Part. No. 56601 B.

Battleships.

The 13,000-Ton Battle Ship Problem. Gives extracts from a letter by Admiral Bradford, protesting against the adoption of the plans submitted by the Board of Construction. Also Admiral Melville's indorsement of the protest. 2200 w. Ir Age—July 30, 1903. No. 56852.

H. M. S. Centurion Reconstructed. Illustration, with description of changes made. 800 w. Engr, Lond—June 19, 1903. No. 56330 A.

Canal-Boat Motors.

The Deutz Boat Motors (Deutzer Bootsmotoren). Julius Küster. Illustrated descriptions of gas generators and engines and their application to canal boats. 1500 w. Zeitschr d Mitteleuropäischen Motorwagen Ver—No. 10, 1903. No. 56227 D.

Cargo Steamer.

German-Built Cargo Steamer. Illustrated description of the cargo ship "Lichtenfels," showing latest practice. 600 w. Marine Engng—July, 1903. No. 56428 C.

Channel Steamers.

Cross-Channel Steamers. Prof. J. H. Biles. Read before the Inst. of Nav. Archts. Considers the points of difference between channel and ocean-going steamers, giving a summary of the lines and tonnage employed, etc. 2200 w. Engng—July 10, 1903. No. 56708 A.

Clyde.

The Clyde and Naval Work. Begins a detailed account of the warship work in hand, done, and proposed to be done on the Clyde. 1500 w. Engr, Lond—July 17, 1903. Serial. 1st Part. No. 56811 A.

Colliers.

Fast Colliers for the British Navy. E. H. T. d'Eyncourt. Presents arguments showing the need of these vessels, and some suggestions regarding them. Ill. 1800 w. Cassier's Mag—July, 1903. No. 56604 B.

Cruiser Trials.

The War Conditions Trial of the Europa and Spartiate. An account of the performance of these cruisers which, it is claimed, have rehabilitated the Belleville boiler. After a trip of 20,000 miles, under trying conditions, no defect of importance is found. 1500 w. Engr, Lond —July 10, 1903. No. 56695 A.

Electricity.

See Electrical Engineering, Miscellany.

Electric Launches.

German, English and American Electric Launches. Frank C. Perkins. Illustration, with brief descriptions of some of these interesting vessels. 1000 w. Marine Engng—July, 1903. No. 56432 C.

See also Street and Electric Railways.

England.

Progress of Warships and Machinery Building in England. A record of what has been accomplished in ship-yards and engine-works during the past half-year ending June 30th. 2300 w. Engr, Lond —July 3, 1903. No. 56584 A.

Evaporators.

Running Evaporators. Earl N. Percy. Remarks on the operation and care of evaporators, describing various methods. 2500 w. Marine Engng—July, 1903. No. 56427 C.

Express Steamers.

Express Steamers for Short Voyages. Albert Edward Seaton. Read at the Engng. Con. of Inst. of Civ. Engrs. Considers the causes of differences in steamers for different routes between England and various points. 3000 w. Engng—July 3, 1903. No. 56581 A.

Floating Docks.

Development in Floating Dry-Docks. Joseph J. Schultz. Points out their striking advantages over the graving type, especially in economy and range of adaptability, and gives in brief the structural features of all the important forms of floating dock. Illustrated. 4000 w. The Engineering Magazine—Aug., 1903. No. 56900 B.

A 6,000-Ton Floating Depositing Pontoon Dock. An illustrated description of the dock at Barcelona. 1800 w. Sci Am —July 11, 1903. No. 56658.

The Barcelona Depositing Dock. Illustrates and describes a depositing floating dock which is an ingenious combination of pontoons and staging which enables several vessels to be repaired at the same time. 700 w. Marine Engng—July, 1903. No. 56423 C.

Italian Steamships.

New Steamship Umbria and Liguria. Brief illustrated description of the last of five vessels of the Nav. Gen. Italiana Co. placed in American service. 900 w. Marine Engng—July, 1903. No. 56426 C.

"Kaiser Wilhelm II."

The "Kaiser Wilhelm II." Gustav H. Schwab. An illustrated detailed description of the newest and largest Atlantic liner. 2500 w. Cassier's Mag—July, 1903. No. 56599 B.

T. S. S. "Kaiser Wilhelm II." An illustrated article giving a general idea of this largest high-speed liner that has yet been completed. Following articles will enter fully into details. 5500 w. Engng—July 10, 1903. Serial. 1st Part. No. 56702 A.

Launch.

The Coaching Steam Launch "Moguntia" (Trainier-Dampf-Schnellboot "Moguntia). An illustrated description of a launch built for a rowing club by Escher Wyss & Co., of "tetrahedral" shape, about 35 feet long and 14 knots speed, and using oil fuel for boilers. 800 w. Zeitschr d Mitteleuropäischen Motorwagen-Ver—No. 5, 1903. No. 56222 D.

Log.

Measurement of the Speed of Ships (Mesure des Vitesses des Navires à la Mer). E. Guyou. Description of a modification of the ship log, the speed of the log line and the revolutions of the main shaft being both electrically registered on a strip of paper. 600 w. Comptes Rendus—May 18, 1903. No. 56945 D.

Mercantile Cruisers.

On Mercantile Cruisers Fitted with

Housing Propellers. James Hamilton Read before the Inst. of Nav. Archts. (England). Suggests a means by which it may be possible, when on passenger service, by holding in reserve a part of the total power provided in the ship, to save a large portion of the proposed subsidies, or the portions connected with running the vessels on passenger service. Also discussion. 2800 w. Engng—July 3, 1903. No. 56580 A.

Model Tank.

Experiment Station for Hydraulics and Shipbuilding, in Berlin (Versuchsanstalt für Wasserbau und Schiffbau in Berlin). Hr. Eger. An illustrated description of a basin for experimenting with ship models, and other features of a plant for making experiments in hydraulic and shipbuilding work. 2800 w. Zentralblatt d Bauverwaltung—April 18, 1903. No. 56210 B.

"Okean."

The Russian School Ship and Transport "Okean" (Das Russische Schul- und Transportschiff "Okean"). An illustrated description of a 12,000-ton steamer built at the Howaldt yard in Kiel, Germany, for the Russian government, to be used as a transport between the Baltic and the Pacific and as a school ship for machinists. Serial. 2 Parts. 3 Plates. 1800 w. Zeitschr d Ver Deutscher Ing—June 27, July 4, 1903. No. 56233 each D.

"Prinz Adalbert."

Twin-Screw Steamer "Prinz Adalbert," of the Hamburg-American Line (Doppelschrauben-Passagier- und Frachtpostdampfer der Hamburg-Amerikalinie, "Prinz Adalbert"). Prof. Oswald Flamm. A well-illustrated description of a passenger and express freight steamer of medium size, built at the Bremen Vulcan yard, in Vegesack, Germany, for the Brazil trade. 6 Plates. 3300 w. Serial. 3 Parts. Schiffbau—May 23, June 8 and 23, 1903. No. 56184 each D.

Rivet Holes.

See Mechanical Engineering, Machine Works and Foundries.

Screw-Shafts.

On Screw-Shafts. John List. Read at Engng. Con. of the Inst. of Civ. Engrs. A discussion of present practice and recent improvements, and of points of special interest. 1200 w. Engng—June 26, 1903. No. 56488 A.

Stability.

The Position of Equilibrium of Undamaged and of Leaking Ships (Die Gleichgewichtslage des Unverletzten und des Lecken Schiffes). Ernst Zetzmann. A discussion of the stability of ships under various conditions, and the mathematical treatment of problems in the trim and stability of ships when in normal condition and with one or more compartments filled with water. Diagrams and curves. Serial. 5 Parts. 3500 w. Schiffbau—May 8, 23, June 8, 23, and July 8, 1903. No. 56183 each D.

Steamboats.

The New Inland Passenger and Freight Steamboat Virginia. Illustrated description of a medium size boat operating on Chesapeake Bay. 1500 w. Naut Gaz—July 2, 1903. No. 56504.

New Steamboat "Middlesex," for the Rappahannock River. Illustrates and describes a paddle steamer built for service between Baltimore and Fredericksburg, Va. 1000 w. Marine Engng—July, 1903. No. 56429 C.

Submarines.

Trials of the Submarine Boats Grampus and Pike. Illustrations with report of trial in San Francisco waters. 800 w. Marine Engng—July, 1903. No. 56431 C.

Turbine Steamers.

Channel Steamship "The Queen." An account of the performance of this new turbine-propelled steamer on the Dover-Calais route. 1600 w. Engr, Lond—July 3, 1903. No. 56585 A.

The Steam Turbine and Its Application to the Propulsion of Vessels. C. A. Parsons. Read before the Inst. of Nav. Archts. An interesting review of the work in this field. Ill. 4500 w. Engng—July 10, 1903. Serial. 1st Part. No. 56705 A.

Yachts.

From Cruiser to Racing Machine. A critical review of the cup-defenders, and the design of racing yachts. 2000 w. Sci Am—July 25, 1903. No. 56791.

MECHANICAL ENGINEERING

AUTOMOBILES.

Agriculture.

The Automobile in Agricultural Service (Der Motorwagen im Dienste der Landwirtschaft). Julius Küster. An illustrated description of the employment of automobiles in varous kinds of agricultural work. 2000 w. Zeitschr d Mitteleuropäischen Motorwagen-Ver—No. 7, 1903. No. 56224 D.

Ardennes Race.

Circuit des Ardennes. A brief account

of this race, with illustrations of some of the vehicles, and table giving time record. 1500 w. Auto Jour—June 27, 1903. No. 56468 A.

Berlin Exhibition.

The German Automobile Exhibition at Berlin, 1903 (Deutsche Automobil-Ausstellung, Berlin, 1903). Julius Küster. An illustrated general description of the exhibition and some of the exhibits, including vehicles, motors, and details. Serial. 2 Parts. 7000 w. Zeitschr d Mitteleuropäischen Motorwagen-Ver—Nos. 5 and 6, 1903. No. 56221 each D.

The German Automobile Exhibition (Von der Deutschen Automobilausstellung). An illustrated description of various automobiles and their parts shown at Berlin in 1903. Serial. Part 1. 3000 w. Ill. Zeitschr f Klein u Strassenbahnen—April 16, 1903. No. 56188 C.

Buck Board.

The Orient Buck Board. Hugh Dolnar. Brief illustrated description of the novel features of this vehicle exhibited at the Am. Auto. Show. 1200 w. Autocar—July 11, 1903. No. 56710 A.

Congress.

The Automobile Congress at Paris. The first of a series of articles reviewing the proceedings of these meetings and the questions discussed. 3500 w. Engr, Lond—July 3, 1903. Serial. 1st Part. No. 56583 A.

Electric Vehicles.

Applications of Electricity to Driving Carriages in Towns. R. E. B. Crompton. Read before the Engng. Con. of the Inst .of Civ. Engrs. Remarks on the transmission, gear, storage batteries used, and tires. General discussion. 3400 w. Elec Engr, Lond—June 26, 1903. No. 56479 A.

The Contal Electromobile. An illustrated description of a carriage having new features in the running gear and battery. 2500 w. Trac & Trans—June, 1903. No. 56301 E.

See also Street and Electric Railways.

Fender.

See Street and Electric Railways.

Fire Engines.

Chemical Motor Fire Engine. Illustrations and brief description of the Tottenham combined motor chemical fire-engine and fire-escape. 1000 w. Auto Jour—July 4, 1903. No. 56556 A.

Motor Steam Fire-Engines. Illustrations and descriptions of these engines, particularly the one built for Leyland, England. 1100 w. Autocar—July 4, 1903. No. 56558 A.

New Motor Steam Fire Engine for Liverpool. Brief illustrated description. 500 w. Engr, Lond—July 10, 1903. No. 56699 A.

Gasoline Vehicles.

A Discussion of the Gasoline Runabout for the Novice. A. D. River. Considers the general features, giving hints of value. 2500 w. Automobile—June 27, 1903. Serial. 1st Part. No. 56366.

Gordon-Bennett Race.

Narrative of the International Cup Contest. Edward Kenealy. Reports of the race and scenes and incidents on Irish soil, with photographs. 4500 w. Automobile—July 18, 1903. No. 56783.

Previous Contests for Possession of the Gordon Bennett Trophy. A brief review of these annual contests which began in 1900. Ill. 1000 w. Automobile—July 4, 1903. No. 56511.

Results of the Gordon Bennett Race. An account of this race which gave the "cup" to Germany. 1,600 w. Automobile—July 4, 1903. No. 56510.

The Gordon Bennett Automobile Cup Race. An illustrated account of this international motor-car race. 2,800 w. Sci Am—July 25, 1903. No. 56790.

The Gordon Bennett Cup Race. An account of preparations in Ireland, the arrival of the cars, and matters of related interest. Ill. 9,500 w. Motor-Car Jour—July 4, 1903. No. 56557 A.

The Gordon Bennett Cup and Race. An illustrated article giving the history of the cup and of the series of international races which have taken place in connection with it. 2500 w. Autocar—July 6, 1903. (Special No.) No. 56686 A.

The Gordon Bennett Cup Race. An illustrated detailed account of this interesting motor race. 3000 w. Motor Car Jour—July 11, 1903. No. 56709 A.

The Irish Fortnight—The Opening Days and the Gordon-Bennett. An illustrated account of the start, finish and incidents. 15,000 w. Auto Jour—July 11, 1903. No. 56692 A.

Highway Rights.

The Motor and the Birthright of the the Highway. Walter B. Woodgate. Discusses the English common-law positions of motorists and the non-motoring public; the proposed legislation and relative matters. 5,500 w. Nineteenth Cent—July, 1903. No. 56669 D.

The Motor Car and the Public. A protest against the abuses which have sprung up in consequence of the development of the motor car and its use on the public highways. 2,800 w. Trac & Trans—July, 1903. No. 56724 E.

Igniter.

See Electrical Engineering, Miscellany.

Jenatzky-Martini.

The Jenatzky-Martini Petrol Cars. Begins an illustrated detailed description of the novel features. 2500 w Auto Jour—June 27, 1903. Serial. First part. No. 56469 A.

Krupkar.

The 16 H.-P. "Krupkar" Petrol Vehicle. Illustrated description. 2400 w. Auto Jour—June 20, 1903. No. 56345 A.

Motor Cycles.

Motor Cycles at the German Automobile Exibition (Motor-Zweiräder auf der Deutschen Automobil Ausstellung.) Julius Küster. An illustrated description of various motor cycles exhibited at the Berlin show, in March, 1903. 1600 w. Zeitschr d Mitteleuropäischen Motorwagen-Ver—No. 7, 1903. No. 56225 D.

Napier Cars.

The Napier Cars and Works. Illustrates and describes recent cars built by this company and the new works at Acton Vale. 3000 w. Auto Jour—July 4, 1903. Serial. First part. No. 56554 A.

Overland Trip.

Overland Trip from the Pacific Ocean. Marius C. Krarup. An illustrated series of articles giving particulars of trip. The present number describes the crossing of the Sierras by way of Placerville to Slippery Ford. 2000 w. Automobile—July 18, 1902. Serial. First part. No. 56784.

Petrol Cars.

The Use of Petrol Motors for Locomotion. E. Sauvage. Read before the Enging Con. of the Inst. of Civ. Engrs. Notes on the desirable qualities of these engines, and on things to be considered where economy is a consideration. 1500 w. Engng—June 26, 1903. No. 56486 A.

A Simple Petrol Car. Illustrates and describes a design aiming to avoid complicated details liable to cause trouble. 1400 w. Engr, London—July 10, 1903. No. 56701 A.

Railway Cars.

See Railway Engineering, Motive Power.

Railway Feeders.

Autocars and Railways. Norman D. Macdonald. Discussing the effect autocars will have on railways and the writer's opinion, with suggestions as to ways railways may use autocars for traffic gaining. 1600 w. Transport—July 3, 1903. Serial. First part. No. 56561 A.

Speed Recorders.

Recorders for the Protection of Automobilists (Selbstschutz Gegen Unrichtige Polizeiliche Denunziationen Durch Geschwindigkeits-Registratoren). An illustrated description of a speed recorder which marks the maximum speed attained and of the "velograph" which traces a continuous record of the motion of a vehicle. 2500 w. Zeitschr d Mitteleuropäischen Motorwagen-Ver—No. 6, 1903. No. 56223 D.

Steam Cars.

Steam Autocar Notes. J. S. V. Bickford. States a preference for water-tube boilers, and gives an account of experiments made both in the shop and on the road. Ill. 3300 w. Engr, Lond—July 17, 1903. No. 56817 A.

The 1903 White Steam Car. Illustrates and describes the interesting features of the present type of these cars. 3000 w. Auto Jour—July 4, 1903. Serial. First part. No. 56555 A.

HYDRAULICS.

Air Lift.

The Raising of Water by Compressed Air. Percy Griffith. Read before the Engng. Con. of the Inst. of Civ. Engrs. A brief summary of the principles governing the operation and of the essential details of construction in its application to the raising of water from wells and borings. 1800 w. Mech Engr—June 27, 1903. No. 56473 A.

Lifting Water by Compressed Air. Gustav C. H. Friedrich. Read before the Ohio Soc. of Mech., Elec. and Steam Engrs. Considers the air-lift pump and the well. 2000 w. Engr, U S A—July 15, 1903. No. 56742 C.

Centrifugal Pumps.

High-Lift Centrifugal Pumps. Cecil West Darley. Read at the Engng. Con. of the Inst. of Civ. Engrs. Describes and gives test of steam turbine-driven centrifugal pumps for high lifts, designed for special conditions in New South Wales. 2400 w. Engng—July 3, 1903. No. 56-582 A.

An Improved Centrifugal Dredging Pump. Capt. Mason M. Patrick. An interesting account of trouble experienced in the wear of pumps used in improving the Mississippi River, with illustrations and description of a design aiming to reduce this wear to a minimum. 1700 w. Eng News—July 9, 1903. No. 56650.

Flow.

Approximate Data of Open Streams, Weirs, Pipes, etc. F. S. Beckett. Gives a graphic table of the results and conclusions of formulæ most often required in the line of work indicated, and problems showing the scope and application. 1500 w. Min & Sci Pr—July 18, 1903. No. 56828.

Plumbing.

Hot Water Supply. Illustrated description of two sketches of kitchen boiler and hot-water supply arrangement where one boiler is above the other. 1500 w. Met Work—July 18, 1903. No. 56654.

Pumping Stations.

See Electrical Engineering, Power Applications.

Turbines.

Progress in Turbine Construction (Fortschritte im Turbinenbau). C. Schmitthenner. A paper giving review of recent progress in turbines and their regulating apparatus, and a particular discussion of Francis turbines, with illustrations and diagrams. Serial. 2 Parts. 5000 w. Zeitschr d Ver Deutscher Ing—June 13 and 20, 1903. No. 56229 each D.

Swiss Turbines of the Girard & Pelton Types. Frank C. Perkins. Illustrates and describes various types used in hydro-electric plants in Europe. 700 w. Min Rept—July 2, 1903. No. 56502.

Water-Wheels.

The Design of Tangential Water Wheels. George J. Henry, Jr. Abstract of a paper read before the Con. of the California Miners' Assn. Discusses the question of governing and the numerous applications of tangential wheels, considering examples taken from actual practice. Ill. 2000 w. Jour of Elec—July, 1903. No. 56615 C.

MACHINE WORKS AND FOUNDRIES.

Apprenticeship.

See Industrial Economy.

Bolts.

The Manufacture of Armour-Plate Bolts. An illustrated description of these bolts and their manufacture. 2000 w. Engng—July 10, 1903. No. 56703 A.

Brass Foundries.

Equipment of Brass Foundries. C. Vickers. Considers the equipment of each shop should be in accordance with the class of work to be done, and offers some suggestions. 1200 w. Am Mach—July 2, 1903. No. 56420.

Castings.

A Small Converter Process for the Manufacture of Steel Castings. Arthur Simonson. A description of the Tropenas process and plant, stating its usefulness and advantages. 2500 w. Foundry—July, 1903. No. 56383.

Castings Finishing.

The Finishing of Castings on Automatic Screw Machines. Gives illustrated description of machines for this work. 1000 w. Engng—July 3, 1903. No. 56579 A.

Clutch Teeth.

The Cutting of Clutch Teeth. Guido H. Marx. An illustrated description of methods of cutting the straight toothed and the saw toothed. 1500 w. Am Mach—July 2, 1903. No. 56416.

Dividing Engines.

The Dividing of Circles in Mechanical Work (Die Ausführung von Kreisteilungen in der Maschinentechnik). F. von Handorff. A thesis at the Hanover Technical Highschool giving an illustrated descripton of methods and machines for dividing circles. Serial. 5 Parts. 18000 w. Zeitschr f Werkzeugmaschinen u Werkzeuger—June 5, 15, 25, July 5 and 15, 1903. No. 56220 each D.

Drilling.

Experiments Upon the Work of Machine Tools. Forces and Work in Drilling (Experiences sur le Travail des Machines-Outils. Efforts et Energies de Forage). M. Codron. A continuation of the author's researches, containing a mathematical study, with many diagrams, of drilling and the power required to drill in various materials. 8000 w. Bull Soc d'Encour—June 30, 1903. No. 56933 G.

Fire Protection.

Fire Protection of Work Shops. J. W. G. Simonds. Considers such apparatus as may be useful to managers of small works to enable them to deal with an outbreak of fire. Ill. 5800 w. Page's Mag—July, 1903. No. 56593 B.

Fitting.

Allowances for Press and Running Fits and for Limits in Bored and Turned Work. Tables and explanatory notes giving the practice of the C. W. Hunt Co. in limits of workmanship for various kinds of work. 900 w. Am Mach—July 16, 1903. No. 56679.

Foundries.

A Modern Iron Foundry (Eine Moderne Eisengiesserei). Oscar Leyde. A well illustrated description of the construction, equipment and operation of the foundry of Ludw. Loewe & Co., Berlin. 4000 w. Stahl u Eisen—June 1, 1903. No. 56271 D.

The New Foundry of the Brown & Sharpe Mfg. Co. An illustrated detailed description of the recent addition to the plant at Providence, R. I. 2800 w. Mach, N Y—July, 1903. Serial. 1st part. No. 56405 C.

The New Foundry of the Sheffield Car Co., Three Rivers, Mich. Brief description, sectional and outline drawings. 500 w. Foundry—July, 1903. No. 56384.

Gauges.

Gauges in Workshops. Herbert J. Marshall. Read at the Engng. Con. of the Inst. of Civ. Engrs. A discussion of gauges and standards as affecting shop and manufactory administration. 2000 w. Engng—June 19, 1903. No. 56322 A.

Gear Cutting.

Automatic Wheel-Cutting Machine. Illustrated description of a machine capable of cutting spur, bevel, and worm gears. 1500 w. Engr, Lond—July 10, 1903. No. 56700 A.

The Art of Generating Gear Teeth. Howard A. Coombs. A review of the class of machines which "generate" the tooth curves, in contradistinction to those machines in which formed cutters or templets are used, previously shaped to the contour of the teeth. 2700 w. Am Mach—July 9, 1903. Serial. 1st part. No. 56622.

Interchangeable Devices.

Jigs and Fixtures for Interchangeable Manufacturing. Joseph V. Woodworth. An illustrated article considering the important factors, the various processes, etc. 3200 w. Ir Trd Rev—July 2, 1903. No. 56518.

Milling.

Milling as a Method of Machining. Charles S. Gingrich. An account of its development in American shop practice, giving illustrations and data showing what can be expected from the intelligent use of the modern milling machine. 4000 w. Cassier's Mag—July, 1903. No. 56-603 B.

Molding.

Molding with Some Carving of Sand. R. H. Palmer. Describes the casting and the method used. 600 w. Am Mach—July 2, 1903. No. 56417.

Pattern Shops.

The Organization, Maintenance and Management of a Modern Pattern Shop. Jos. Leon Gobeille. Discusses remedies and improvements needed. Ill. 1800 w. Jour Am Found Assn—June, 1903. No. 56853.

Plate Straightening.

Plate-Straightening Rolls. Illustrated detailed description of machine constructed for the new armor-plate mills at Creusot. 600 w. Engng—June 19, 1903. No. 56310 A.

Riveted Joints.

A Table for Pitch and Efficiency of Riveted Joints. Philip B. Hill. Gives table prepared to facilitate the design of a riveted joint for any given case, explaining its use. 1000 w. Eng News—July 16, 1903. No. 56753.

Rivet-Holes.

Drilled v. Punched Rivet-Holes in the Hulls of Ships. A. F. Yarrow. Read at the Engng. Con. of the Inst. of Civ. Engrs. Gives results of experience thus far, describes and illustrates the methods of drilling, and strongly favors the drilling. 1400 w. Engng—June 26, 1903. No. 56485 A.

Shaft Couplings.

Dimensions for Flanged Shaft Couplings. S. H. Bunnell. Describes method used by a small shop in revising their whole set of patterns for flanged couplings with a view to consistency. 500 w. Am Mach—July 16, 1903. No. 56680.

Spelters.

Making Brazing Spelters. Walter J. May. Suggestions for making spelter by one operation with once heating. 400 w. Prac Engr—June 19, 1903. No. 56308 A.

Thread Cutting.

Tools and Methods for Accurate Thread Cutting. Jos. M. Stabel. An illustrated article describing the methods of a writer who has had large experience. 1500 w. Mach, N Y—July, 1903. No. 56406 C.

Wheels.

The Manufacture of Car and Locomotive Wheels and Tires (Beiträge zur Fabrikation der Eisenbahnräder und Bandagen). An illustrated description of the manufacture of wheels as carried out at one of the Krupp works, including solid steel wheels and various other kinds. 1500 w. Ill Zeitschr f Klein u Strassenbahnen—June 16, 1903. No. 56191 C.

Winding Machine.

Winding Machine for Coils of Flat Copper Ribbon. An illustrated description of a remarkable machine, the invention and design of Mr. John Riddell, which winds automatically and edgewise upon various forms. 1000 w. Am Mach—July 9, 1903. No. 56624.

MATERIALS OF CONSTRUCTION.

Alcohol Fuel.

Alcohol Considered as a Fuel (L'Alcool Considéré comme Combustible). Edmond Brunet. General considerations and statistics of prices and production of alcohol in Germany and France and its use as a fuel. 2600 w. Rev Technique—July 10, 1903. No. 56927 D.

Alloys.

An Introduction to the Study of Alloys. Prof. Henry M. Howe. A brief and very clear explanation of the modern theory of the constitution of metals, of its conclusions as affecting the materials of engineering construction, and of the methods of study and investigation by which the facts are established. Serial. 1st part. 4000 w. Ill. The Engineering Magazine—Aug., 1903. No. 56298 B.

Iron, Steel, and Other Alloys. First chapter of Prof. Henry M. Howe's new book on alloys. Ill. 4000 w. Metallographist—July, 1903. No. 56665 F.

Alloys of Iron, Nickel and Manganese. R. A. Hadfield. Read before the Engng. Con. of the Inst. of Civ. Engrs. Describes this alloy, which has shown remarkable properties. Gives results obtained in tests.

700 w. Ir & Coal Trds Rev—June 26, 1903. No. 56492 A.

Alloys of Copper and Antimony (Les Alliages de Cuivre et d'Antimoine). M. Baykoff. A study of the properties of these alloys when cooling rapidly and slowly, with micrographs and diagrams. 1800 w. Bull Soc d'Encour—May 31, 1903. No. 56928 G.

Bronze.

An Account of Bronze Casting in Egypt, Europe and Japan. Randolph I. Geare. History of the art. 5500 w. Sci Am Sup —July 25, 1903. No. 56795.

Cast Iron.

Cast Iron for Dynamo and Motor Frames. H. E. Diller. Read at meeting of the Am. Soc. for Test Materials. Considers the requirements for use in dynamo and motor frames, and the problems it presents to the designer, especially as to its magnetic qualities. 1800 w. Ir Trd Rev—July 9, 1903. No. 56620.

On the Constitution of Cast Iron. Henry M. Howe. Read at meeting of the Am. Soc. for Test. Materials. A study of the relation between the composition and properties of cast iron. Ill. 9500 w. Metallographist—July, 1903. No. 56566 F.

Journal Brasses.

A Study of Alloys Suitable for Bearing Purposes. G. H. Clamer. Particularly a study of alloys suitable for railway journal bearings, considering composition, structure, friction, temperature of running, wear on bearing, wear on journal, compressive strength, and cost. Studies the combinations in present service. 7800 w. Jour Fr Inst—July, 1903. No. 56393 D.

Nickel Steel.

The Metallography of Nickel Steel (La Metallographie des Aciers au Nickel). Dr. Léon Guillet. A micrographic study of the constitution and properties of nickel steel, in various proportions, with many illustrations. 6000 w. Bull Soc d'Encour —May 31, 1903. No. 56930 G.

Recent Researches in Nickel Steel (Nouvelles Recherches sur les Aciers au Nickel). Dr. Léon Guillet. An account of micrographic and other research work, with tables and diagram. 1600 w. Génie Civil—June 27, 1903. No. 56915 D.

Nickel-Steel. Crittenden Marriott. On the very peculiar qualities of this alloy, being nearly if not quite exempt from expansion and contraction through heat and cold, and also showing curious phenomena relating to magnetism, and the advantage in constructing surveying levels. 1600 w. Sci Am—July 11, 1903. No. 56655.

Specifications.

The Making of Specifications. Dr. C. B. Dudley. President's address before the Am. Soc. for Test. Materials. On the making of specifications for materials, describing the methods practiced at Altoona in connection with the laboratory of the Pennsylvania R. R., and giving the writer's views. 5700 w. Ir Age—July 9, 1903. No. 56537.

Springs.

Springs. William Metcalf. Read before the Am. Soc. for Test. Materials. Gives a short history of conditions and changes of the past 30 years in car and locomotive springs; the first specifications; those now used; the treatment, classes of springs, testing, etc. 5000 w. Ir Age—July 9, 1903. No. 56536.

Steels.

I. Dilatation of Steels at High Temperature. Georges Charpy and Louis Grenet. II. Transformation of Steel by the Dilatometric Method. Two papers by the same authors from *Comptes Rendus Academie des Sciences.* Experimental studies. 1200 w. Metallographist—July, 1903. No. 56667 F.

MEASUREMENT.

Balance Lever.

The Balance Lever as a Calculating Machine. Ulrich Peters. Gives practical applications of the lever, with an illustrated description. 1400 w. Ir Age—July 23, 1903. No. 56775.

Curved Rods.

The Determination of the Stresses in Curved Rods (Zur Ermittelung der Spannungen Krummer Stäbe). Prof. M. Tolle. A mathematical discussion of the stresses in curved pieces, such as the links of chains, etc., with diagrams. 4500 w. Zeitschr d Ver Deutscher Ing—June 20, 1903. No. 56231 D.

Metric System.

The Metric Convention and the International Bureau of Weights and Measures (La Convention du Mètre et le Bureau International des Poids et Mesures). Ch. Ed. Guillaume. A continuation of the history of the metric system, with appendices giving accounts of important conventions and meetings, and record of the adoption of the metric system by various countries. 16000 w. Bull Soc d'Encour—June 30, 1903. No. 56934 G.

Shafts.

Calculations for Loaded Shafts Rotating at High Speeds (Méthode de Calcul des Arbres Chargés Animés de Grandes Vitesses de Rotation). M. Delaporte. Mathematical discussion of the forces acting on and the stresses in shafts of steam turbines, etc. Diagrams. 4000 w. Rev de Mécanique—June 30, 1903. No. 56935 E + F.

Testing Laboratory.

The Testing Laboratory of the Conservatoire des Arts et Métiers (Le Laboratoire d'Essais du Conservatoire des Arts et Métiers). A. Dumas. An illustrated description of the new French national testing and research laboratory, connected with the famous conservatory of arts and trades. 2800 w. Génie Civil—July 11, 1903. No. 56919 D.

POWER AND TRANSMISSION.

Air-Compressor Explosions.

Accidents Due to Combustion Within Air-Compressors. E. Hill. Discussion of the paper of Dr. Albert R. Ledoux. A mathematical discussion of the heat of compression in air-cylinders. 1200 w. Trans Am Inst of Min Engrs—Feb., 1903. No. 56763.

Air Compressors.

High-Speed Air Compressors (Ueber Kompressoren mit Erhöhten Umdrehzahlen). Hr. Harth. A discussion of the changes in steam-driven air compressors to give them higher speed, and of their efficiency. Diagrams. 1 Plate. 3500 w. Glückauf—Feb. 14, 1903. No. 56285 D.

Belt Driving.

Practical Belt Driving. John Tullis. Abstract of a paper read before the Aberdeen Mech. Soc. Discusses points of importance in belt driving, the power transmitted, slipping, compounding, high speed, kinds of belts, jointing, dressing, etc. 5800 w. Mech Engr—July 11, 1903. No. 56711 A.

Coal Handling.

Coal Handling Machinery and Its Application to Steam Power Plants. T. F. Webster. Discusses particularly the methods of mechanically handling coal in steam power plants, and other classes in connection with such plants. Ill. 6000 w. Pro Engrs Soc of W. Penn—May, 1903. No. 56858 D.

Automatic Machinery for Handling Coal. Day Allen Willey. Illustrates and describes various forms of conveying machinery. 1200 w. Sci Am—July 4, 1903. No. 56465.

Cranes.

Hoisting Apparatus at the Düsseldorf Exposition (Die Hebezeuge auf der Düsseldorfer Ausstellung). S. Fraenkel. A paper before the Verein Deutscher Maschinen-Ingenieure, giving an illustrated account of large traveling cranes and other kinds of hoisting machinery. Serial. Part I. Tables. 2500 w. Glasers Annalen—July 1, 1903. No. 56243 D.

Cranes on Dover Pier. An illustrated description of the special cranes installed to facilitate the handling of baggage and mails, with report of the official trials. 1100 w. Engr, Lond—July 17, 1903. No. 56814 A.

Economical Speeds of Cranes. Archibald Potter Head. Read before the Engng. Con. of the Inst. of Civ. Engrs. On the speeds of overhead and other cranes as a factor in economical handling of material in working, dealing with the different designs seriatim. 2000 w. Engng —June 19, 1903. No. 56320 A.

Portable Pneumatic Revolving Cranes. Illustrates and describes a special form of locomotive crane designed to be operated with compressed air. 900 w. Eng News—July 23, 1903. No. 56846.

See also Electrical Engineering, Power Applications.

Flywheels.

Flywheels. William H. Boehm. Considers the more frequent causes of flywheel disruptions, discussing points of interest in connection with the design and operation of flywheels of various types. 2400 w. Engr, U S A—July 15, 1903. Serial. First part. No. 56741 C.

Gears.

Investigation of a Three Thread Worm Gear. E. Bach and E. Roser. Translated in abstract, from the *Zeitschrift der Vereines Deutscher Ingenieure*, by E. P. Buffet. Describes experiments made at the engineering laboratory of the Royal Tech. High School, Stuttgart. Ill. 1400 w. Am Mach—July 16, 1903. Serial. 1st part. No. 56681.

Lubrication.

Friction and Lubrication. J. Stormonth. References to the light gained through the experiments of Mr. Towers, Prof. Goodman and others, is made and points bearing on this subject discussed. 3500 w. Engr, Lond—June 19, 1903. No. 56331 A.

Screw Conveyor.

A 650-foot Screw Conveyor (Transport par Hélices à 200 Mètres de Distance). An illustrated description of a helical conveyor, worked in sections by a steel cable, for transporting the pressed material from a beet-sugar factory to canal boats or wagons. 1000 w. Génie Civil—May 30, 1903. No. 56907 D.

Slag Conveyor.

A New Cupola Slag Conveyor. Thomas D. West. Brief illustrated description. 300 w. Jour Am Found Assn—June 1903. No. 56855.

Tightening Pulley.

Transmission of Motion by Belts or Cables by Means of the Leneveu Tightening Pulley (Transmissions de Mouvement par Courroies ou Cables. Enrouleur-Debrayeur du Capitaine Leneveu). Ch. Dantin. An illustrated description of power transmission in general, and particularly, of the Leneveu balanced tightening pulley, which greatly increases the arc of contact of belt or rope. 3500 w. Génie Civil—June 20, 1903. No. 56912 D.

SPECIAL MOTORS.

Bavaria.

See Mechanical Engineering, Miscellany.

Canal-Boat Motors.

See Marine and Naval Engineering.

Dynamo Driving.

Internal-Combustion Engines for Driving Dynamos. Herbert A. Humphrey. Read at the Engng. Con. of the Inst. of Civ. Engrs. Considers the types of gas-engines now made for driving dynamos, giving figures showing the number of impulses per revolution and the horse-power up to which each type is constructed. 2800 w. Engng—June 19, 1903. No. 56321 A.

Gas Engines.

Power and Economy of the Gas Engine as Influenced by the Fuel. William P. Flint.. A short paper discussing the commercial gases, follow d by general discussion. 2500 w. Pro Engrs Soc of W Penn—May, 1903. No. 56857 D.

Contributions to the Design of Gas Engines (Beiträge zur Berechnung der Gasmaschine). Rudolf Barkow. A discussion, with formulæ and diagrams, of some points in the theory and design of gas engines. 1500 w. Zeitschr d Ver Deutscher Ing—June 27, 1903. No. 56235 D.

Air ana Gas Mixtures, Explosion Pressures, and Cylinder Proportions of Gas Engines. James Dunlop. Gives method of determining the above points, devised by the writer, and agreeing closely with practice. 1600 w. Mech Engr—July 18, 1903. No. 56805 A.

Butler's 5,000 H. P. 3-Cylinder Double-Acting Compound Gas Engine. Illustrations and particulars of a vertical engine designed by Edward Butler. 800 w. Mech Engr—June 20, 1903. No. 56347 A.

Management of the Gas Engine. A. Stritmatter. Hints on the proper oiling, need of cleanliness, etc. 1800 w. Gas Engrs' Mag—July 10, 1903. No. 56804 A.

Gas Engines Using Producer Gas (Gasmaschinen für Generatorgas). R. W. Hilgenstock. A paper before the Technischer Verein of Philadelphia, giving a general illustrated account of gas engines and their development. 3000 w. Technologist—April, 1903. No. 56195.

Igniter.

See Electrical Engineering, Miscellany.

Oil-Engines.

The Britannia Oil Engine. Illustrated description of the Nicholson engine, in which no external source of heat is used in vaporizing the oil, but is capable of running for long periods under light load. 900 w. Engng—June 19, 1903. No. 56311 A.

The Kynoch-Forward Oil-Engine. Illustrated description of a new design, with report of trial. 1600 w. Engng—June 19, 1903. No. 56313 A.

STEAM ENGINEERING.

Bavaria.

See Mechanical Engineering, Miscellany.

Blowing Engines.

Notes on Steam-Driven and Gas-Driven Blowing-Engines. Tom Westgarth. Read before the Engng. Con. of the Inst. of Civ. Engrs. Considers these engines individually, and also the question as to which type is more economical and more suitable for the work. 1500 w. Engng—June 19, 1903. No. 56326 A.

Boiler Testing.

Engine and Boiler Testing. W. H. Booth. A discussion of methods of testing and their value. 2000 w. Mach, N Y—July, 1903. No. 56407 C.

Coal-Dust Fuel.

Coal-Dust Burning Process. C. O. Bartlett. Read at meeting of Engrs.' Club of Cleveland. Considers things necessary to obtain satisfactory results, the advantages to be gained and the obstacles to be met. 2000 w. Ry & Engng Rev—July 25, 1903. No. 56850.

The Combustion of Lean Coal Dust (Ueber Verfeuerung von Magerfein-Kohlen). H. Schäfer. A discussion of grates and methods of firing for very small sizes of lean coal. 1000 w. Glückauf—June 20, 1903. No. 56293 D.

Condensation.

A Novel Method of Air-Cooling. Arthur Pennell. Illustrates and describes devices for dissipating the latent heat of condensed steam into the atmosphere by utilizing the ability of the air to absorb water vapor. 2200 w. Engr, U S A—July 15, 1903. No. 56743 C.

Condensing Plants.

Central Condensation Plants at the Düsseldorf Exposition (Les Condensations Centrales à l'Exposition de Düsseldorf). P. F. Dujardin. A well illustrated description of cooling towers and other steam-condensing apparatus. 1 Plate. 2200 w. Génie Civil—May 30, 1903. No. 56905 D.

The Mars Vertical Displacement Air Pump. An illustrated description of the Thomas and Marsland's patent condensing plant. 500 w. Engr, Lond—June 26, 1903. No. 56494 A.

Condensing Plant for Central Electric Stations. R. D. Summerfield. Illustrates and describes some of the modern arrangements and discusses the subject generally. 2200 w. Engng—July 17, 1903. Serial. 1st part. No. 56818 A.

Engine Drawings.

Drawings of Modern Triple-Expansion Engines. Gives a set of working drawings of a modern triple-expansion engine of the vertical inverted cylinder, direct-connected, triple-expansion type, explaining the correct names of the different parts. 700 w. Marine Engng—July, 1903. No. 56425 C.

Engine Stops.

An Improved System of Engine Stops. An illustrated description of the Monarch system which works automatically. 2000 w. Sci Am Sup—July 11, 1903. No. 56-662.

Evaporators.

See Marine and Naval Engineering.

Feed-Water Heater.

McBride's Locomotive Feed Water Heater. Illustration and statement of the advantages of this system, invented by T. C. McBride. 1700 w. R R Gaz—July 17, 1903. No. 56754.

Feed-Water Purifiers.

New Controller of Boiler Water. Description, with illustrations, of an apparatus used on Dutch steamers and in Dutch factories where carbonate of soda is added to the water to prevent incrustation. 1200 w. U. S. Cons. Reports. No. 1699—July 17, 1903. No. 56645 D.

The Harris-Anderson Water Softener. Illustrated description of this apparatus and its operation. 2300 w. Enging—July 10, 1903. No. 56704 A.

Four Systems of Softening Water for Industrial Purposes. Illustrated descriptions of the Pittsburg, New York-Continental Jewel, Breda and Tweeddale systems respectively. 3800 w. Eng News—July 2, 1903. No. 56414.

Liquid Fuel.

Liquid Fuel for Power Purposes. Arthur L. Williston. A thorough presentation of the economic side of the question, with figures and diagrams showing the fluctuation of production and price over long periods, and an estimate of the future supply of fuel oil. Illustrated. 3200 w. The Engineering Magazine—August, 1903. No. 56904 B.

Lubrication.

Cylinder Oil and Cylinder Lubrication. Henry M. Wells. An article dealing with cylinder oil for steam engines. How to find the best oil for given working conditions. Gives a general outline of the process of manufacture and treatment of cylinder oil. 2500 w. Engr, Lond—July 17, 1903. Serial. First part. No. 56809 A.

Piping.

High Pressure Steam Piping. William Andrews. Read before the Engine B'ldrs Assn. of the U. S. Reviews the progress during the last twenty-one years, and describes present practice, considering design, quality of material and the method of disposing of the water of condensation. 2200 w. Power—July, 1903. No. 56410 C.

Pressure-Reducing Valves.

Valves for Reducing Steam Pressures (Das Dampfdruckminderungsventil). Siegfried Mertens. A discussion of means for perfecting steam pressure reduction valves and calculating their performance. 2500 w. Gesundheits-Ingenieur—May 10, 1903. No. 56197 B.

Rolling-Mill Engine.

The Reconstruction of a Twin Reversing Rolling Mill Engine, with Rattmann Valve Gear (Umbau einer Zwillings-Reversiermaschine mit Rattmann Steuerung). An account of the conversion of a twin reversing engine into a tandem compound, with a consequent saving in steam. Indicator diagrams. 1 plate. 600 w. Stahl u Eisen—July 1, 1903. No. 56279 D.

Rotary Engines.

The Warren Rotary Engine. An illustrated detailed description of the engine and its operation. 2200 w. Ir Age—July 9, 1903. No. 56535.

Smoke Prevention.

Steam Jets for Preventing Smoke. R. H. Palmer. Illustrates and describes a blower in use at the works of William Allen & Sons Co., Worcester, Mass., and its satisfactory working. 700 w. Am Mach—July 2, 1903. No. 56418.

Smoke Abatement. George Thomas Beilby. Read at Engng. Con. of the Inst. of Civ. Engrs. Refers to subjects now being investigated which will have a bearing on the question, and suggests that a tax be levied on the use of smoke-producing fuel. Gives interesting information. 1400 w. Engng—June 26, 1903. No. 56-489 A.

Steam Engines.

The 4,000-Horse Power Engines at the Third Avenue, Brooklyn, Power House. An illustrated detailed description of these engines. The present installation comprises 8 4,000-h. p. engines direct-connected to both direct and alternating current generators. They are arranged in four pairs. 2300 w. Power—July, 1903. No. 56408 C.

Steam Heating.

Description of a Low-Pressure Steam Heating System which Proved Defective in Operation. John Gormly. Read at meeting of Am. Soc. of Heat and Ven. Engrs. Description of the plant which was installed. 1600 w. Met Work—July 25, 1903. No. 56800.

The Regulation of Low Pressure Steam-Heating Systems (Die Erzielung der Generellen Regelung der Niederdruckdampfheizungen). Prof. Rietschel. A mathematical and experimental discussion of the proper diameter of pipes and of the general regulation of pressure and heating in steam heating systems. 4000 w. Gesundheits-Ing—June 20, 1903. No. 56200 B.

Steam and Its Application to the Heating of Railway Carriages. A paper read by Mr. Claypool before the British Inst. of heat and Ven. Engrs. on the heating and ventilation of railway cars, the systems in use, &c. General discussion follows. 4000 w. Dom Enging—July 25, 1903. No. 56826 C.

Steam-Heating Station.

The Royal Central Heating and Electric Station at Dresden (Königliches Fernheiz- und Elektrizitätswerk zu Dresden). R. Trautmann. An illustrated description of a large central steam heating plant, in an ornamental building, for heating the principal public buildings in Dresden, Germany. 1 plate. 5000 w. Glasers Annalen—July 15, 1903. No. 56245 D.

Heat and Electric Light Distribution in Dresden. C. Arldt. Illustrates and describes the installation of the Dresden heating and electric light generating station, which supplies heat and light to royal, municipal and other buildings. 2200 w. Trac & Trans—June, 1903. No. 56306 E.

Steam Loop.

A Few Points on the Steam Loop. H. H. Kelley. Read before the Ohio Soc. of Mech., Elec. and Steam Engrs. Explains this arrangement of piping and its principle of operating, illustrating by examples. 2000 w. Engr, U S A—July 1, 1903. No. 56549 C.

Steam Turbines.

Steam Turbines. Prof. Rateau. Remarks showing the possibilities of steam turbines, and describing some recent designs. 1000 w. Prac Engr—June 26, 1903. No. 56476 A.

The Rateau Steam Turbine. Illustrations, with description of the construction of the machine, and an account of the principles and tests. 2000 w. Elec Wld & Engr—July 25, 1903. No. 56837.

The Steam Turbine (La Turbine a Vapeur.) M. Raucour. A general review of steam turbines, principally of the Parsons type, for driving electric generators, with results of operation. 4000 w. Rev Technique—May 25, 1903. No. 56920 D.

Steam Turbines (Les Turbines a Vapeur). A. Abraham. Illustrated. General review. Serial. Part 1. 1200 w. Rev Technique—July 10, 1903. No. 56926 D.

Notes on Parson's Steam Turbines (Mitteilungen über Parsons-Dampfturbinen). Hans Dominik. An illustrated description of various steam turbine plants in Germany, France and Switzerland, and results of tests. 3000 w. Ill Zeitschr f Klein u Strassenbahnen—April 1, 1903. No. 56186 C.

See Also Marine and Naval Engineering.

Superheating.

Progress in the Use of Superheated Steam (Fortschritte in der Anwendung des Ueberhitzten Dampfes). A paper by Director Burkhardt before the "Eisenhütte Oberschlesien," giving a general account of the application of superheated steam for engines and of superheating systems. Serial. Part 1. 5000 w. Stahl u Eisen—July 15, 1903. No. 56281 D.

A Century of Superheated Steam. E. P. Watson. Explains the term; discussing the difficulties encountered in its use, and its value. 2500 w. Ir Age—July 16, 1903. No. 56683.

Some New Types of Superheaters. Prof. W. H. Watkinson. Read before the Inst. of Naval Archts. Illustrates and describes various superheaters designed by the author, which are giving exceedingly satisfactory results. Briefly explains the objects and advantages of superheating. 5000 w. Enging—July 10, 1903. No. 56707 A.

Thermodynamics.

A New Theory of Heat Power Plants. Robert H. Smith. The first of a series of articles on the relation of heat to mechanics. 3500 w. Engr, Lond—July 10. 1903. Serial. First part. No. 56698 A.

Valves.

Replacing a Slide Valve with a Piston Valve. J. P. Badenhausen. Describes the method of making the change, and explains why it was undertaken. Ill. 1100 w. Marine Enging—July, 1903. No. 56433 C.

Waste Steam.

Utilizing the Waste Steam from Winding Engines. Translated from *Glückauf*. Illustrated description of an interesting device recently installed in a colliery at Bruay (Pas-de-Calais). 800 w. Col Guard—June 26, 1903. No. 56484 A.

MISCELLANY.

Aeronautics.

The Balloon "Lebaudy" (Le Ballon "Lebaudy"). Lieut. Col. G. Espitallier A well illustrated description of a long balloon with a flat under surface, rudders and propellers, which has made successful trips in France. 6000 w. Génie Civil—June 13, 1903. No. 56911 D.

The New Santos-Dumont Airships. An illustrated article reporting the performance of No. 9, and describing features of interest. 1200 w. Sci Am—July 11, 1903. No. 56656.

The Sahara Aeronautical Experiments at Gabes, Tunis (Les Experiences Aérostatiques Sahariennes de Gabes). Leo Dex. Illustrated account of the sending of an experimental balloon across part of the Sahara desert, from Gabes, Tunis. Serial Part 1. 1300 w. Rev Technique—June 25, 1903. No. 56924 D.

Scientific Kite Flying. W. H. Dines. An illustrated account of experiments made in flying kites from the deck of a steam vessel stationed on the west coast of Scotland. 1800 w. Nature—June 18, 1903. No. 56340 A.

The Spontaneous Combustion of Balloons Upon Landing (Sur l'Incendie Spontané de Ballons Pendant l'Atterrisage). W. de Fonveille. An account of explosions presumably caused by the balloon acquiring an electric charge and being discharged when the aeronaut steps on the ground and touches the valve rope. 600 w. Comptes Rendus—May 11, 1903. No. 56944 D.

Agricultural Machinery.

The Royal Show. An account of the 64th annual exhibition of the Royal Agricultural Society, giving illustrated descriptions of interesting exhibits. 3800 w. Engr, Lond—June 26, 1903. Serial. First part. No. 56497 A.

Bavaria.

The Historical Development of Engineering in Southern Bavaria (Die Geschichtliche Entwickelung der Technik im Südlichen Bayern). P. v. Lossow. A general historical and descriptive review of technical progress, with illustrations. 16000 w. Zeitschr d Ver Deutscher Ing—July 4, 1903. No. 56236 D.

New Products of the Munich and Augsburg Engine Industry (Neure Leistungen der München—Augsburger Maschinenindustrie). Prof. M. Schröter. An illustrated account of locomotives, compressors, Diesel motors and other engines manufactured in these Bavarian cities. 6000 w. Zeitschr d Ver Deutscher Ing—July 11, 1903. No. 56239 D.

Drawing Office.

Some Features of the Drawing Office System of the C. W. Hunt Company. Description, with illustrations. 1600 w. Am Mach—July 9, 1903. No. 56623.

Gravitation.

The Mechanical Cause of Gravitation. Robert Stevenson. An experimental study. 1600 w. Elec Wld & Engr—July 11, 1903. No. 56640.

Heating and Ventilation.

The Heating and Ventilation of Foundries and Machine Shops. W. H. Carrier. States the difficulties to be overcome and shows the adaptation of the fan system to the solution. Ill. 2800 w. Jour Am Found Assn—June, 1903. No. 56854.

Heating and Ventilating the Machine Shop. J. I. Lyle. On the utilization of exhaust steam for heating, considering the three systems adapted to its use. 2500 w. Can Engr—July, 1903. No. 56509.

The Economical Heating of Railway Repair Shops. W. H. Carrier. Explains the difficulties to be overcome in the heating of shop buildings, and offers suggestions as to general methods of air distribution. Ill. 2700 w. Ry Age—June 30, 1903. (Daily Ed.) No. 56514.

See also Mechanical Engineering, Steam Engineering.

Heat Radiators.

The Scientific Basis and Commercial Feasibility of Heat Radiators, Using Air Instead of Water or Steam. George M. Aylesworth. Read at meeting of Am. Soc. of Heat & Ven. Engrs. Describes the system as adopted by the writer and its successful application to house warming. Ill. 2300 w. Met Work—July 25, 1903. No. 56799.

Phonograph Records.

Moulded Records for Phonographs. An illustrated article describing fully the making of master records, and the mold from which duplicates are made. 2200 w. Am Mach—July 9, 1903. No. 56621.

Refrigeration.

Cooling of Dwellings. Alfred Siebert. Explains a system of artificial cooling, and how to control humidity, etc. 1800 w. Ice & Refg—July, 1903. No. 56517 C.

United States.

A Journey in the United States for the Purpose of Studying the Mechanical Industries (Eine Studienreise in den Vereinigten Staaten von Amerika). Paul Möller. An account of American technical and industrial conditions, as seen on a trip through the United States by a representative of the Verein Deutscher Ingenieure. Serial. 2 Parts. 7000 w. Zeitschr d Ver Deutscher Ing—July 4 and 11, 1903. No. 56237 each D.

Windmills.

Windmills. Sidney Russell. An illustrated review of the old type of windmills, now disappearing. 11400 w. Trac & Trans—June and July, 1903. Serial. 2 Parts. No. 56304 each E.

COAL AND COKE.

Analysis.

The Determination of Sulphur in Coal. Charles W. Stoddart. Abstract from the *Jour. Am. Chem. Soc.* Gives details of the various methods used, describing the standard method. 2000 w. Eng & Min Jour—June 27, 1903. No. 56441.

British Columbia.

Coal Production of British Columbia. Information from the annual report of the Minister of Mines. 3000 w. Col Guard —July 3, 1903. No. 56577 A.

Coal-Cutting Machines.

Coal-Cutting Machines (Haveuses Mécaniques Employées dans les Mines de Houille). J. Rosset. Illustrated descriptions of many kinds of drills and other coal-cutting machinery. Serial. Part 1. 1600 w. Génie Civil—July 4, 1903. No. 56918 D.

Experiments With Percussive Coal-Cutting Machines (Versuche mit Stossenden Schrämmaschinen). Hr. Brandi. An account of tests of coal-mining machines acting by percussion and using compressed air, in the Dortmund district, Germany. Tables. 1000 w. Glückauf—July 4, 1903. No. 56296 D.

Coal-Cutting Machinery. H. Baddeley. Read before the Nat. Assn. of Colliery Mgrs. Gives the writer's experience in this field, discussing the conditions favorable and unfavorable to the use of machinery and other points of interest. 3800 w. Ir & Coal Trds Rev—July 17, 1903. No. 56824 A.

Notes on Percussive Coal-Cutters. Sir Thomas Wrightson and John Morison. Read at the Engng. Con. of the Inst. of Civ. Engrs. Discussion of why these machines which have proven profitable in America, have not been so considered in England. Describes a machine designed by the writers to meet British conditions. 1800 w. Engng—June 19, 1903. No. 56-323 A.

Coal Cutting by Machinery. J. W. Chubb. Discusses the advantages of mechanical coal cutters, and reviews their history. Gives illustrated descriptions of various types. 5000 w. Fielden's Mag—July, 1903. No. 56592 B.

Coal Mining.

Wages and Profits in Coal Mining. Tabulated statistics from a pamphlet issued by the British Board of Trade showing the quantity and value of coal produced in the United Kingdom and the number and average wages of coal miners, etc. 1800 w. Ir & Coal Trds Rev—June 19, 1903. No. 56333 A.

Exhibition.

International Colliery Exhibition. A comprehensive illustrated description of the various exhibits at the Agricultural Hall, London. 10800 w. Col Guard—July 10, 1903. Serial. First part. No. 56693 A.

The Colliery Exhibition at the Royal Agricultural Hall, London. Brief illustrated descriptions of some of the more interesting exhibits. 16000 w. Ir & Coal Trds Rev—July 3, 1903. No. 56589 A.

Explosions.

Dusty Shots as a Factor in Coal Dust Explosions. Henry S. Munroe. Gives instances showing that dusty shots, in combination with blown-out shots, must be taken into serious consideration in devising means for preventing such explosions. 3500 w. Eng & Min Jour—June 27, 1903. No. 56438.

Firedamp Explosions in the Dortmund District, Germany, With Relation to the State of the Barometer in 1902 (Die Schlagwetter-Explosionen im Oberbergamtsbezirk Dortmund mit Beziehung auf den Barometerstand im Jahre 1902). Statistics and discussion of the relation between firedamp and atmospheric pressures. 1 Plate. 1200 w. Glückauf—June 13, 1903. No. 56292 D.

Fossils.

Codonotheca, a New Type of Spore-Bearing Organ from the Coal Measures. E. H. Sellards. An illustrated description of a peculiar type of fructification. 4000 w. Am Jour of Sci—July, 1903. No. 56382 D.

German Iron Works.

The Acquisition of Coal Mines in the Ruhr District, Germany, by Iron Companies (Erwerbung von Steinkohlengruben im Ruhrkohlenbezirk durch Hüttenwerke). Hr. Hundt. An account of the increasing ownership of their own coal mines by iron works, and a discussion of general effects of this practice. 5000 w. Stahl u Eisen—July 1, 1903. No. 56277 D.

Handling Coal.

See Mechanical Engineering, Power and Transmission.

Hauling.

Notes on the Utilization of Surplus Power in a Self-Acting Incline at Redheugh Colliery. C. H. Steavenson. Describes a method of hauling coals by means of the surplus power derived from

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a self-acting incline. 1500 w. Ir & Coal Trds Rev—July 3, 1903. No. 56590 A.

Mules.

Care and Protection of Mules in Mines. Gives rules and regulations issued to employees by the Delaware & Hudson Co. at Scranton, Pa. 3800 w. Mines & Min—July, 1903. No. 56377 C.

Peat.

Peat Fuel. W. H. Booth. Discusses the possibility of the peat industry in Ireland, stating what has been accomplished in Germany. 3500 w. Eng, U S A—July 1, 1903. No. 56547 C.

Queensland.

Queensland Coal Mines. Information from the annual report of W. Fryar, Inspector of Mines. Ill. 5500 w. Queens Gov Min Jour—May 15, 1903. No. 56-379 B.

COPPER.

Arizona.

The Shannon Copper Mine and Other Properties. T. F. Swanwick. Illustrations and description of the mines in the Clifton region. 2500 w. Pacific C Min—July 4, 1903. No. 56608.

British Columbia.

Mount Sicker Mining District, British Columbia. W. M. Brewer. Gives the history of these copper mines, their development, geology, treatment, etc. 3800 w. Min & Sci Pr—July 4, 1903. No. 56618.

Copper-Matte.

Relative Elimination of the Impurities in Bessemerizing Copper-Matte. W. Randolph Van Liew. Gives results obtained in determining the relative rate and in finding the point where different impurities are eliminated. 700 w. Trans Am Inst of Min Engrs—October, 1903. No. 56765.

Mansfeld.

The Report of the Mansfeld Copper Company, of Eisleben, Germany, for 1902 (Verwaltungsbericht der Mansfeldschen Kupferschiefer Bauenden Gewerkschaft zu Eisleben für das Jahr 1902). An abstract of the report of this great copper and silver mining company, giving production and financial statistics. 1500 w. Glückauf—May 16, 1903. No. 56287 D.

Metallurgy.

Notes on the Metallurgy of Copper of Montana. Prof. H. O. Hofman. Condensed account of past and present plants. the ores, metallurgical treatment, melting, converting copper-matte, electrolytic refining, etc. 1800 w. Trans Am Inst of Min Engrs—February, 1903. No. 56770 D.

Review of the Recent Progress in the Metallurgy of Copper. Stuart Croasdale. Remarks on the metallurgy of the sulphide ores of copper, showing a record of most rapid advancement. 4800 w. Pacific C Min—June 27, 1903. No. 56500.

Michigan.

Copper Mining in Upper Michigan. J. F. Jackson. Read at a meeting of the West. Soc. of Engrs. An illustrated description of the region, the mines, and some of the methods and machinery used. 6000 w. Mines & Min—July, 1903. No. 56372 C.

Queensland.

The Garnet-Formations of the Chillagoe Copper Field, North Queensland, Australia. George Smith. Describes this field and the deposits, particularly the secondary deposits connected with the garnet. Ill. 3600 w. Trans Am Inst of Min Engrs—October, 1903. No. 56762.

Utah.

The Premier Copper Camp of the Wasatch Mountains. Henry M. Adkinson. An illustrated account of mining operations at Bingham, Utah. The ores are copper, copper-iron sulphides and galena. Gold, silver and zinc are present. 6800 w. Pacific C Min—June 20, 1903. No. 56365.

The Copper Deposits of the Beaver River Range, Utah. Henry M. Crowther. Describes the deposits of this region. 1200 w. Eng & Min Jour—June 27, 1903. No. 56439.

Wyoming.

Silver Crown Copper District. An illustrated article describing the extensive development work in progress by the Hecla Gold and Copper Mining, Milling and Smelting Company. 1700 w. Min Rept—July 16, 1903. No. 58779.

GOLD AND SILVER.

Briquetting.

Briquetting Precious Mineral Ores. William G. Irwin. Reviews briefly what has been accomplished, especially in America. 1200 w. Sci Am—July 11, 1903. No. 56659.

California.

Observations on Mother-Lode Gold-Deposits, California. William A. Pritchard. A study of the geology of these deposits. 4500 w. Trans Am Inst of Min Engrs—Oct., 1903. No. 56766.

Colorado.

A Promising Gold Field, and Tests by Sampling. An illustrated account of the deposits on the Trinchera Estate in Costilla Co., Colo., consisting of beds of gold-bearing quartzite. Also a discussion of methods of sampling, and the best method of procedure. 1700 w. Eng & Min Jour—July 18, 1903. No. 56730.

Cripple Creek.

The Bottom Levels at Cripple Creek. George J. Bancroft. Gives a statement of the experience of a number of representative mines. 2800 w. Eng & Min Jour—July 18, 1903. No. 56728.

Cyanide Process.

The Synthetic Cyanide Process. Dr. Fritz Roessler. Extract from a paper read at the Berlin International Cong. of Ap. Chem. Brief comment on the four processes furnishing mainly the world's supply—the Siepermann, the Beilby, the Raschen, and the improved Castner process. 500 w. Jour Gas Lgt—July 14, 1903. No. 56788 A.

Estimation of Cyanide in Cyanide Solutions. J. E. Clennell. Abstract of paper read before the Inst. of Min. & Met., London. Gives method of estimating free cyanide, and also methods of estimating "total cyanide." 1400 w. Eng & Min Jour—July 4, 1903. No. 56528.

A Secondary Reaction in Cyaniding. Dr. J. Ohly. A study of causes that explain the difference in results in the laboratory and in actual practice, with explanations of secondary, partial, and reversible reactions and other points bearing on this subject. 1800 w. Min Rept —July 2, 1903. No. 56503.

Cyaniding in Montana. Matt. W. Alderson. Discusses what the process is; how, and to what ores it may be applied; giving some facts, and costs. 2800 w. Mines & Min—July, 1903. No. 56373. C.

Cyaniding in the Black Hills, S. D. J. B. Empson. Describes a type of the wet-crushing mills of this district. 1600 w. Min & Sci Pr—June 27, 1903. No. 56521.

Cyaniding Sulpho-Telluride Ores. Philip Argall. Compares the method of working ores in the raw state, by means of fine grinding and subsequent treatment with bromocyanide, known as the Diehl process, with the roasting method as practiced on the ores of Cripple Creek. 2000 w. Eng & Min Jour—July 11, 1903. No. 56631.

The Cyaniding of Some Silver Ores by Percolation. Andre P. Griffiths and Frank W. Oldfield. Abstract from the Pro. of Inst. of Min. & Met., London. Notes on results obtained in the cyanide treatment of low-grade ores of the Palmarejo Mines, in Mexico, which have proved commercially successful. 2000 w. Eng & Min Jour—July 18, 1903. No. 56-731.

See also Industrial Economy.

Gold Dredging.

Dredging in the Ovens Valley. General remarks on dredging work, with illustrated description of the plant of the Ovens Valley Gold Dredging Co., Victoria. 2200 w. Aust Min Stand—June 11, 1903. No. 56553 B.

Mercur's Mines.

No Gold in Limestone an Exploded Theory. L. H. Beason. Reviews the history of these Utah mines and the methods used, and considers that there is no reason why they should not continue to be dividend payers. Ill. 2500 w. Pacific C Min—June 27, 1903. No. 56499.

Milling Costs.

Gold Milling Costs. S. Horsley. States the difficulties in the way of a proper comparison of the total cost of extraction on the various gold-fields, giving information and a comparative table of gold milling and mining costs. 2000 w. Queens Gov Min Jour—May 15, 1903. No. 56-378 B.

Ore Treatment.

Filter-Press Treatment of Gold Ores and Slimes by Cyanide. An account of improvements made in this process and the success attained. Suggestions for the proper treatment of different varieties of ore. 4000 w. Min & Sci Pr—July 4 and 11, 1903. Serial. 2 Parts. No. 56617.

Quartz Milling.

Notes on the Common Practice of Quartz Milling on the Rand. Fraser Alexander. Discussion of this paper. 5500 w. Jour Chem & Met Soc of S Africa—May, 1903. No. 56575 E.

Samples.

A New Wet Sampler. Edgar Smart. Drawings and description of a new design invented by J. Higham. 1500 w. Page's Mag—July, 1903. No. 56595 B.

San Juan.

Across the San Juan Mountains. T. A. Rickard. An account of the mining districts of these Colorado mountains. The present article gives information of the American Nettie mine, and the Bachelor mine. Ill. 1700 w. Eng & Min Jour —July 4, 1903. Serial. 1st Part. No. 56524.

Silver-Lead.

Santa Eulalia Mines. Prof. Arthur Lakes. A trip to the ancient and very rich silver-lead mines in the Santa Eulalia mountains, near Chihuahua, Mexico, is illustrated and described. 2300 w. Mines & Min—July, 1903. No. 56370 C.

Transvaal.

Mining in South Africa. I.—The Transvaal Gold Production. J. H. Curle. Considers it certain that this region will stand first in production, and begins a study of the mining industry of South Africa, and the conditions to be met. 1800 w. Eng & Min Jour—July 11, 1903. Serial. 1st Part. No. 56628.

Recent Improvements in Gold Mining Machinery on the Rand. Arthur E. T. Lees. Read before the Engng. Con. of the Inst. of Civ. Engrs. Describes improvements made in haulage, boiler plants, stamp mills, mill-engines, winding-engines, rock-drilling, mine pumps, etc. 1400 w. Engng—June 19, 1903. No. 56324 A.

IRON AND STEEL.

Africa.

The Iron Ore Deposits of Northwest Africa (Die Eisenerzlagerstätten Nordwestafrikas). Hr. Baum. An illustrated account of iron ore deposits and mines in Morocco, Algiers and Tunis. Map. 1 Plate. 7000 w. Stahl u Eisen—June 15, 1903. No. 56273 D.

Blast-Furnace Explosions.

Blast-Furnace Explosions With Falling Charges (Hochofenexplosionen beim Stürzen der Gichten). Bernhard Osann. A discussion of the causes of blast-furnace explosions. 2800 w. Stahl u Eisen—July 1, 1903. No. 56280 D.

The Cause of Some Blast Furnace Explosions. Extract from a paper by Director Schilling at meeting of the Verein Deutscher Eisenhuettenleute. Explains his view as to the cause of explosions following "hanging." 1500 w. Ir Age—July 2, 1903. No. 56421.

Blast-Furnace Products.

Blast-Furnace By-Products and Their Possible Recovery. Horace Allen. Gives a list of the by-products, the profitable recovery of which has been demonstrated, and considers them seriatim. Ill. 3500 w. Feilden's Mag—July, 1903. No. 56-591 B.

Blast Furnaces.

The Equalization of Hot-Blast Temperatures for Blast-Furnaces. Joseph Hutchinson Harrison. Read at the Engng. Con. of the Inst. of Civ. Engrs. Describes an apparatus known as an "equalizer" and its action. 900 w. Engng—June 19, 1903. No. 56325 A.

Gas Analysis Calculation of a German Blast Furnace Producing Grey Foundry Iron (Gasanalytische Durchrechnung eines Deutschen Hochofens auf Graues Giessereiroheisen). Dr. C. Waldeck. An analytical investigation of the raw materials entering into and the gases and other products coming from a blast furnace. 2000 w. Stahl u Eisen—June 1, 1903. No. 56272 D.

Cast Iron.

See Mechanical Engineering, Materials of Construction.

Charging Apparatus.

Recent Electric Charging Appliances for Open-Hearth Furnaces (Ueber Neuere Elektrisch Betriebene Beschickungsvorrichtungen für Herdöfen). Oskar Simmersbach. An illustrated review of some American, German and other electric charging apparatus for open-hearth furnaces. 2500 w. Stahl u Eisen—July 15, 1903. No. 56284 D.

Comparative Costs.

The Cost of Production of Pig Iron in America, Great Britain and Germany (Die Gestehungskosten des Amerikanischen Roheisens im Vergleich zu Grossbritannien und Deutschland). O. Simmersbach. Comparative tables and statistics. 1600 w. Glückauf—May 16, 1903. No. 56-286 D.

Crystallization.

The Dangerous Crystallization of Mild Steel and Wrought Iron. J. O. Arnold. Illustrates a machine for testing vibratory brittleness and reviews various investigations in this field. 1000 w. Ir & Coal Trds Rev—June 26, 1903. No. 56493 A.

Electric Rolling Mill.

See Electrical Engineering, Power Applications.

Frozen Furnaces.

The "Freezing" of Blast-Furnaces and the Remedies Therefor (Das Auftreten von Rohgängen und Ihre Beseitigung). E. Jagsch. An illustrated account of the way the contents of blast furnaces become solidified, partly or wholly, and of the methods for removing the obstructions and restoring normal working. 2500 w. Stahl u Eisen—July 15, 1903. No. 56-282 D.

Lake Superior Co.

The Consolidated Lake Superior Company. Information from President Shields' report on the various productive properties of the Company. 3000 w. Ir Age—July 23, 1903. No. 56774.

Magnetic Concentration.

Progress in Magnetic Concentration of Iron Ore. J. Walter Wells. Discusses concentration, reasons for concentrating iron ores, methods, and the present status of magnetic concentration, describing a few machines in use. 6000 w. Can Min Rev—June 30, 1903. No. 56459 B.

Molybdenite.

Molybdenite and the Commercial Products Derived Therefrom. Dr. J. Ohly. Concerning this mineral, recently applied to the improvement of carbon steel, and the treatment it requires. 1200 w. Min Rept—July 16, 1903. Serial. 1st Part. No. 56780.

Open-Hearth.

The Productions of Open-Hearth Steel from Molten Blast-Furnace Metal. Benjamin Talbot. Read before the Engng. Con. of the Inst. of Civ. Engrs. An outline of the continuous process, with some results obtained. 1100 w. Ir & Coal Trds Rev—June 26, 1903. No. 56491 A.

Ore Testing.

The Evolution of the Determination of Iron in Ores. Harrison W. Craver. A review of methods used from the earliest times to those now in common use. 3000 w. Pro Engrs Soc of W Penn—May, 1903. No. 56859 D.

Pig Iron.

Machine Cast Sandless Pig Iron. Edgar S. Cook. Read before Am. Soc. for Test. Materials. Its relation to the standardizing of pig iron for foundry purposes is discussed, and its advantages stated. 5200 w. Ir Age—July 9, 1903. No. 56538.

Railway Iron.

Iron in Railway Service (Das Eisen in der Eisenbahn nach Beschaffenheit, Form und Masse). Dr. A. Haarmann. A paper before the International Congress of Applied Chemistry, giving a general review of iron and steel in their relation to railways, of iron and steel rails and of the growth of railways. 6000 w. Stahl u Eisen—June 15, 1903. No. 56274 D.

Regenerative Valves.

New Valves for Regenerative Furnaces. Illustrates and describes the Czekalla system, and the Naegel system, both of which close the valves at one end of the furnace before those at the other end are opened. 1800 w. Ir Age—July 23, 1903. No. 56-776.

Reversing Apparatus for Siemens-Martin Furnaces (Umsteuerungsvorrichtung für Siemens-Martinöfen). Josef Czekalla. An illustrated description of apparatus for reversing the flow of gases and air in regenerative furnaces, without losing any gas. 1600 w. Stahl u Eisen—June 15, 1903. No. 56276 D.

Rolling.

The Determination of Power for Rolling Iron and Steel. Louis Katona. A discussion intended to give light on questions bearing upon this subject. 4000 w. Trans Am Inst of Min Engrs—Feb., 1903. No. 56767 C.

Sauveur Method.

Pipeless Ingots by the Sauveur Overflow Method. Albert Sauveur and Jasper Whiting. Read at meeting of Am. Soc. for Test. Materials. Brief illustrated description of a method believed to be practical for the casting of pipeless ingots. 2000 w. Ir Trd Rev—July 9, 1903. No. 56619.

Specifications.

The Steel Manufacturers' Standard Specifications. Albert Ladd Colby. Abstract of a paper read before the Am. Soc. for Test. Materials. Information in regard to the revised "manufacturers' standard specifications" and their requirements. 1600 w. Eng Rec—July 18, 1903. No. 56735.

See also Civil Engineering, Bridges.

Swedish Iron.

The Swedish Lancashire Iron. Birger F. Burman. Discusses points in the manufacture of this iron which is often called "the best iron in the world." 2700 w. Ir Age—July 16, 1903. No. 56685.

Utah.

The Utah Iron Fields. An account of these deposits, and the plans for mining and manufacturing. 2800 w. Ir Age—July 16, 1903. No. 56684.

Vermilion Range.

Test Drilling on the Vermilion Iron Range. Kirby Thomas. Describes the methods of test drilling adopted. Ill 1700 w. Eng & Min Jour—June 27, 1903. No. 56440.

MINING.

Ankylostomiasis.

Ankylostomiasis and Measures Taken to Combat It (Die Wurmkrankheit und die zu Ihrer Bekämpfung Getroffenen Massnahmen). Dr. Weidtman. A paper before a Dortmund mining society, giving a description of this worm disease, which is prevalent among German miners, and of the measures taken to prevent it and stamp it out. 5500 w. Glückauf—June 6, 1903. No. 56290 D.

Ankylostomiasis in the Coal Mines of the Liége District, Belgium (Die Wurmkrankheit in den Kohlenbergwerken des Lütticher Reviers). Dr. Löbker, Hrn. Bingel, Lüthgen and G. A. Meyer. A report of a German commission sent to investigate the worm disease among the Belgian coal miners. 3000 w. Glückauf—June 27, 1903. No. 56295 D.

Arid Regions.

Mining Camps in an Arid Region. Prof. Arthur Lakes. Calls attention to things that are absolute necessities if they are to be prosperous. 2000 w. Mines & Min—July, 1903. No. 56375 C.

Coal-Cutting Machines.

See Mining and Metallurgy, Coal and Coke.

Core Drilling.

Core Drilling Without Diamonds. An illustrated description of core drilling by the steel-shot process. 800 w. Sci Am—July 18, 1903. No. 56676.

Development.

Mine Development Methods. B. J. Forrest. Notes on prospecting, proving and testing deposits, developing, transport, etc. 1400 w. Can Min Rev—June 30, 1903. No. 56457 B.

The Payment of Extensions of Mining Plant Out of Revenue. Discusses the suitability of the ordinary methods of accounting to the case of mining. 1600 w. Eng & Min Jour—July 11, 1903. No. 56629.

Electric Machinery.

See Electrical Engineering, Power Applications.

English School.

The History of the English School of Mines. Outlines the history of the Royal School of Mines, giving illustration of the building. Also editorial on the recent announcement that it was to become a part of the technical college at South Kensington, and protesting against such action. 1800 w. Eng & Min Jour—July 25, 1903. No. 56838.

Freezing Process.

Sinking a Shaft of a Coal Mine, at Eygelshoven, Holland, by the Freezing Process (Das Abteufen des Schachtes I der Bergwerkgesellschaft Laura und Vereenigung zu Eygelshoven, Holländisch Limburg, mittels Gefrierverfahrens). R. Pierre. An illustrated description of the sinking of a shaft through 300 feet of watery sand. 2 Plates. 3500 w. Glückauf—May 23, 1903. No. 56288 D.

Miner's Phthisis.

Miner's Phthisis. William Cullen. Reply to discussion on writer's paper on this subject. 2700 w. Jour Chem & Met Soc of S Africa—May, 1903. No. 56574 E.

Mining Machinery.

Compressed Air and Electricity in Mining Operations. W. L. Saunders. A discussion of the paper of W. B. Clarke, on "Electrical Apparatus for Coal-Mining." 5000 w. Trans Am Inst of Min Engrs—Feb., 1903. No. 56760.

Early History of Mining Machines in Great Britain. C. M. Percy. Describes some of the first machines and explains reasons why they did not succeed. 2800 w. Mines & Min—July, 1903. No. 56376 C.

Mining with Machine Drills. E. L. LeFevre. Discusses air power as a factor in economic mining. 2000 w. Min & Sci Pr—July 11, 1903. Serial. 1st Part. No. 56727.

See also Electrical Engineering, Power Applications; and Mining and Metallurgy, Coal and Coke.

Rope Haulage.

Penwyllt Haulage. A statement of the conditions to be met at the Penwyllt Dinas Silica Brick-Works, Wales, with an illustrated description of the special system of endless rope haulage adopted on account of its low initial cost and its economy in working. 1100 w. Col Guard—June 19, 1903. No. 56332 A.

Safety Appliance.

Safety Appliance for Working Steep Seams. From *Zeitschrift für Berg-, Hütten-, und Salinenwesen.* Brief illustrated description of arrangements used at Polnisch-Ostrau. 300 w. Col Guard—July 3, 1903. No. 56576 A.

Smokeless Powders.

Smokeless Powders: Their History and Present Classification. Brief review of different stages in its development, with present classification. 2000 w. Sci Am Sup—July 25, 1903. No. 56796.

Stamps.

Direct Steam Ore Stamps. Charles H. Fitch. Describes some of these stamps calling attention to some of their disadvantages. 1700 w. Min & Sci Pr—July 11, 1903. No. 56726.

MISCELLANY.

Alloys.

Alloying by Means of Metallic Salts. Walter J. May. Some points from the writer's experience showing the process is of some importance in practical working. 1000 w. Prac Engr—June 26, 1903 No. 56475 A.

See also Mechanical Engineering, Materials of Construction.

Alluvial Deposits.

Measurements Relating to Alluvial Deposits. Ralph L. Montagu. Illustrates a drill-hole computer, explaining its use. 1000 w. Min & Sci Pr—June 27, 1903. No. 56519.

Analysis.

A System of Qualitative Analysis Including Nearly All the Metallic Elements. Arthur A. Noyes. The aim of this investigation is to work out in detail a universally applicable scheme which shall include as nearly as practicable all the metallic elements, and make possible their detection even when present in quantity as small as one or two milligrams. 1600 w. Tech Quar—June, 1903. Serial. 1st Part. No. 56388 E.

British Columbia.

Mining in British Columbia. Information from the official report of the minister of mines, in regard to production, value, etc. 500 w. U S Cons Repts, No. 1686—July 1, 1903. No. 56348 D.

Diamonds.

The Mining of Diamonds. A brief account of mining in South Africa. 1200 w. Min & Sci Pr—June 27, 1903. No. 56520.

Do Diamonds Occur in German Southwest Africa? (Kommen in Deutsch-Südwestafrika Diamanten Vor?) Hr. Mentzel. A comparison of analyses of minerals from Gibeon, in German Southwest Africa, and from Kimberley, showing the similarity, and a discussion of the probability of diamonds occurring at the former place. 1200 w. Glückauf—June 13, 1903. No. 56291 D.

Dust Analysis.

A New Process for the Quantitative Determination of Dust in Gases (Ein Neues Verfahren zur Quantitativen Bestimmung von Staub in Gasen). Leo Martius. An illustrated description of apparatus and methods for analyzing dust, particularly that in blast-furnace gases. 1400 w. Stahl u Eisen—June 15, 1903. No. 56275 D.

Fire Brick.

Fire-Resisting Masonry in Iron and Steel Manufacture (Einwirkung Zerstörender Einflüsse auf Feuerfestes Mauerwerk im Hüttenbetriebe). Bernhard Osann. A general discussion of firebrick and other fire-resisting masonry, and the causes which tend to injure them. 4000 w. Stahl u Eisen—July 15, 1903. No. 56283 D.

Frank Disaster.

The Turtle Mountain Rock Slide. Walton E. Dowlen. An illustrated description of the conditions which give an explanation of this disaster in Alberta, Canada. 2000 w. Eng & Min Jour—July 4, 1903. No. 56526.

Furnaces.

An Experimental Reverberatory Furnace. Woolsey McA. Johnson. An illustrated detailed description of two small furnaces for the study of ordinary metallurgical processes. 1400 w. Eng & Min Jour—July 18, 1903. No. 56729.

On Adobe and Other Makeshift Furnaces. Henry F. Collins. Abstracted from the Proceedings of the Institute of Mining and Metallurgy, London. Describes primitive appliances used for temporary work, often useful to meet special conditions. Ill. 3500 w. Eng & Min Jour—July 11, 1903. Serial. 1st Part. No. 56630.

Geology.

Geologizing by the Seaside. Prof. Arthur Lakes. Illustrations of geological phenomena related to mining, as shown in the sea cliffs and caves at La Jolla, near San Diego, Cal. 3300 w. Mines & Min—July, 1903. No. 56374 C.

German Colonies.

Mineral Products of the German Protectorates (Die Gewinnung Mineralischer Bodenschätze in den Deutschen Schutzgebieten). Hr. Macco. A review, founded on government reports, of the mineral industry of the German possessions in Africa and the Pacific. 1500 w. Glückauf—May 30, 1903. No. 56289 D.

Hot Springs.

Hot Springs. Edouard Suess. A study of the phenomena of hot springs. Translated from the German. 2800 w. Eng & Min Jour—July 4, 1903. Serial. 1st Part. No. 56525.

Lead.

The Chemical and Fire Methods of Determining Lead in Ores. R. F. McElvenny and G. A. Izett. Discusses various wet methods, aiming to determine their efficiency and defects, and to find one applicable to present needs. 1800 w. Min Rept—July 2, 1903. Serial. 1st Part. No. 56501.

The Commercial Assay of Lead Ores. A. W. Warwick. Read at meeting of the Colorado Sci. Soc. Also discussion. Briefly considers the fire assay, which the writer considers inaccurate; and the volumetric method, which he considers sufficiently accurate for all commercial purposes. 2200 w. Min Rept—July 9, 1903. No. 56609.

The Refining of Lead Bullion. F. L. Piddington. An account of the Parkes' process of desilverizing and refining lead bullion, as carried out at the works of the Smelting Co. of Australia. 2400 w. Jour Chem & Met Soc of S Africa—May, 1903. No. 56573 E.

Legislation.

Historical Sketch of Mining Legislation in Mexico. Eduardo Martinez Baca. 18000 w. Trans Am Inst of Min Engrs—Oct., 1903. No. 56769 D.

Minnesota.

The Geology of Minnesota. Prof. C. W. Hall. Address before the International Min. Cong. A description of the various formations in the state, and an account of their products which are of economic value. 4500 w. Mines & Min—July, 1903. No. 56371 C.

Nickel.

Nickel Deposits in New Caledonia. Major R. G. Leckie. Information in regard to the deposits found on this island of the Southern Pacific, analysis, methods of mining, and related matters. 2000 w. Can Min Rev—June 30, 1903. No. 56458 B.

Nickel Steel.

See Mechanical Engineering, Materials of Construction.

Opal-Mining.

The Queensland Opal Mining Industry. C. F. V. Jackson. Report for 1902. The conditions were unfavorable owing to the failure of the rainfall for the sixth year in succession. Gives information of the principal districts, and thinks the future prospects encouraging. 2600 w. Queens Gov Min Jour—May 15, 1903. No. 56380 B.

Petroleum.

The Barboursville Oil-Field, Kentucky. S. W. McCallie. An illustrated description of this field in the southeastern corner of Kentucky, and information regarding it. 1200 w. Eng & Min Jour—July 4, 1903. No. 56527.

Pyrometer.

See Electrical Engineering, Measurement.

Sudbury, Ont.

The Ore Deposits of Sudbury, Ontario. Charles W. Dickson. This district is one of the two great sources of nickel. Considers the relation of nickel to pyrrhotite, and the genesis of the ores. Ill. 21500 w. Trans Am Inst of Min Engrs —Feb., 1903. No. 56758 D.

Zinc.

Notes and Data of Interest to Zinc Miners. W. George Waring. Discusses the valuation of zinc ores, the specific gravity and composition of zinc minerals, and assay results as a guide in ore-dressing. 1500 w. Eng & Min Jour—July 4, 1903. No. 56529.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accident.

The Leven Viaduct Accident. An account of a railway accident in which a train was blown bodily over on its side, giving anemometer records made during the night of the accident. 900 w. Engr, Lond—July 3, 1903. No. 56588 A.

Accident Service.

Prompt Aid in Railway Accidents (Des Prompts Secours dans les Accidents de Chemins de Fer). P. Redard. An illustrated description of hospital cars and accident service maintained by some Continental railways. 3000 w. Génie Civil—June 6, 1903. No. 56910 D.

Discipline.

Notes on Discipline. A. J. Love. On the importance of discipline in railroad work, the force of correct habits, and related subjects. 1500 w. R R Gaz—July 17, 1903. No. 56755.

Fast Runs.

A Royal Train "Record." Brief account of a run made by the Royal train on the Great Western Railway, from London to Cornwall. 600 w. Engr, Lond—July 17, 1903. No. 56815 A.

A "Record" Run on the London and South-Western. Charles Rous-Marten. An interesting account of the inaugural trip of fast service on the road named. 3300 w. Engr, Lond—July 10, 1903. No. 56694 A.

Great Northern Records Between London and Leeds. Charles Rous-Marten. A report of two record trips on this British railway. 2000 w. Engr, Lond—July 17, 1903. No. 56813 A.

High Speeds on Railways. James Charles Inglis. Read at the Engng. Con. of the Inst. of Civ. Engrs., England. Considers the design of permanent way and locomotives for high speed. 1500 w. Engng—June 19, 1903. No. 56314 A.

MOTIVE POWER AND EQUIPMENT.

Adhesion Increasers.

Arrangements for Temporarily Increasing the Adhesion of the Driving Wheel of Locomotives (Vorrichtungen zur Zeitweiligen Erhöhung des Triebraddruckes bei Lokomotiven). Prof. K. Keller. Illustrated descriptions of various methods of increasing the portion of the weight of locomotives resting on the drivers at starting. 5000 w. Zeitschr d Ver Deutscher Ing—June 20, 1903. No. 56230 D.

Brakes.

Foundation Brake Rigging. Henry Kolsath. Read at meeting of the New England R. R. Club. Discusses the design and construction of foundation brake gear in detail. 2800 w. R R Gaz—July 24, 1903. No. 56848.

Car Capacity.

The Increase in Capacity of Open Freight Cars on the Prussian State Railways (Ueber die Erhöhung der Ladefähigkeit der Offenen Güterwagen bei den Preussischen Staatsbahnen). Hr. von Schwabe. A discussion of the question of increasing the capacity of cars, and figures showing the relations between live and dead loads on German and American railways. 2000 w. Glasers Annalen—July 1, 1903. No. 56244 D.

Car Heating.

See Mechanical Engineering, Steam Engineering.

Cars.

Progress in Car Building. Editorial review of recent improvements and designs, the troublesome details, types, etc. 2000 w. R R Gaz—June 26, 1903. No. 56456.

Long Passenger Cars for the Monon. Plans, elevation and description of a combination passenger and baggage car with steel under frame; and a ladies' coach, 70 ft. 8 in. in length, seating 88 persons. 450 w. R R Gaz—June 26, 1903. No. 56451.

New Coaches on the Central London Railway. Illustration with brief description of new motor coach adopted to lessen the vibration. 600 w. Engr, Lond—July 3, 1903. No. 56587 A.

Draft Connections.

Drawbar and Buffer Attachments for Use Between Engine and Tender. Henry Bartlett. Read at convention of Am. Ry. Mas. Mechs. Assn. A discussion of the best arrangement, the form and relative strength of the drawbar to tractive power of the engine, etc. Ill. 2800 w. Ry Age —June 27, 1903. (Daily Ed.) No. 56513.

Dust Guard.

The Symington Dust Guard. An illus trated detailed description. 1000 w. R R Gaz—June 26, 1903. No. 56453.

Injectors.

Injectors as They Are Met With in Every Day Railway Practice. F. W. Edwards. Introductory to a general discussion. Considers the mounting of injectors, location on different classes of boilers, care, failures, etc. 11000 w. Pro W Ry Club—May 19, 1903. No. 56352 C.

Internal-Combustion Engines.

Internal Combustion Engine in Railway Service. Abstract of a paper by R. P. C. Sanderson before the Mas. Mechs.' Assn. Thinks these engines will soon invade the field now occupied by steam locomotives. 1300 w. Ry & Engng Rev —June 27, 1903. No. 56460.

Locomotives.

British and Continental Locomotive Types. Charles S. Lake. Brief discussion of various types of engines employed in dealing with specified classes of traffic. Ill. 1800 w. Prac Engr—June 19, 1903. Serial. 1st Part. No. 56307 A.

Atlantic Type Engine in Germany. Illustrated description of a German four-cylinder Atlantic type compound. 450 w. Loc Engng—July, 1903. No. 56411 C.

Consolidation Locomotive for Southern Railway. Illustrated description of simple cylinder balanced slide valve engines. 700 w. Ry & Engng Rev—July 4, 1903. No. 56523.

Fast Freight Engines for the Lackawanna. Illustrated description of medium size mogul locomotives, for hauling fast freight; some for the use of soft coal, and others for anthracite, the only difference being in the fireboxes. 700 w. Ry Age—June 26, 1903. No. 56369.

Narrow-Gauge Tank Locomotive for the Bengal-Nagpur Railway. Two-page plate and other illustrations of an exceptionally powerful narrow-gauge engine. 600 w. Engng—July 3, 1903. No. 56578 A.

Ten-Wheel Compound Locomotive for the Chicago & Eastern Illinois. Illustrated detailed description of engines for heavy passenger or fast freight service. 500 w. Ry Age—July 10, 1903. No. 56648.

Two Large Express Passenger Locomotives. Illustrations, with brief descriptions of engines for use on the Caledonian and North-Eastern Railways. 500 w. Mech Engr—June 27, 1903. No. 56472 A.

See also Mechanical Engineering, Miscellany.

Motor Cars.

Automobile Cars and Locomotives for Railways (Gleis-Motorwagen und Gleis-Motorlokomotiven). Julius Küster. Illustrated description of automobiles for hauling cars or for carrying loads themselves, adapted to run on tracks. 1 Plate. 3000 w. Zeitschr d Mitteleuropäischen Motorwagen-Ver—No. 9, 1903. No. 56226 D.

Light Motors on Local Railways (Einführung Leichter Motoren beim Betriebe auf Lokalbahnen). Illustrated description of steam motor cars, built by F. X. Komarek, to replace locomotives on some Austrian railways. 1 Plate. 1000 w. Mitt de Ver f d Förderung d Lokal u Strassenbahnwesens—April, 1903. No. 56193 D.

Purrey Steam Motor Cars on French Railways (Voitures Automotrices à Vapeur, Système V. Purrey). J. Tête. Illustrated descriptions of passenger cars with steam motors, one on the Paris-Lyons-Mediterranean, and another on the Orleans Railway, with results of operation. 2 Plates. 4000 w. Rev Gén Chemins d Fer—July, 1903. No. 56942 H.

Steel Cars.

Steel Cars Without Center Sills. E. W. Summers. Suggests changes that might be advantageously made in steel cars, especially discussing the doing away with the center sill. General discussion. Ill. 13400 w. Pro Ry Club of Pittsburg —March, 1903. No. 56353 C.

Modern Steel Cars. Illustrations, and brief descriptions of recent designs. 1200 w. R R Gaz—June 26, 1903. No. 56454.

Train Lighting.

See Electrical Engineering, Lighting.

Train Resistance.

Frictional Resistances on Railways (Der Reibungs-Widerstand bei Schienenbahnen). A discussion of the various resistances met with by trains moving on rails, with formulas and diagrams. Serial. 2 Parts. 9000 w. Ill Zeitschr f Klein u Strassenbahnen—June 1 and 16, 1903. No. 56190 each C.

German Tests of Railway Train Resistance. Prof. Albert Frank, in the *Zeitschrift des Vereins Deutscher Ingenieure.*

A report of a series of tests at different speeds carried out on the state railways of the kingdom of Hanover, Germany. 1000 w. Eng News—June 25, 1903. No. 56361.

Weed-Burning.

New Weed-Burning Cars, C. M. & St. P. Ry. Illustrated description of one of the new machines for this purpose, with an account of its working. 1500. Ry & Engng Rev—June 27, 1903. No. 56461.

Wheels.

See Mechanical Engineering, Machine Works and Foundries.

NEW PROJECTS.

Anatolia.

Construction Work on the Anatolian Railway, Turkey (Von der Anatolischen Eisenbahn). Hr. Denicke. An illustrated description of tunnel repair work on this road in Asiatic Turkey. 1400 w. Zentralblatt d Bauverwaltung—April 4, 1903. No. 56208 B.

Austria.

New Railway Construction in Austria (Die Eisenbahnenbauten in Oesterreich). A description, with map and profiles, of new railways under construction in different parts of Austria. Serial. Part 1. 1200 w. Zentralblatt d Bauverwaltung—July 11, 1903. No. 56219 B.

China.

The Shan Tung Railway (Ueber die Shantung Eisenbahn). A. Gaedertz. An address before the Verein für Eisenbahnkunde, giving an account of the railway being built by the Germans in the northeastern part of China. Profile. 5000 w. Glasers Ann—July 1, 1903. No. 56242 D.

Ireland.

The Letterkenny and Burton Port Railway. An illustrated account of railway work in the west of Ireland, particularly the Burton Port extension, a government subsidized light railway. 3000 w. Transport—July 3, 1903. No. 56560 A.

Manchuria.

The Chinese Eastern (Manchurian) Railway. Alfred Stead. An illustrated description of the Manchurian railway based upon notes personally made during a tour of inspection. 2300 w. Page's Mag—July, 1903. No. 56594 B.

PERMANENT WAY AND BUILDINGS.

Gauge.

The Choice of Gauge on Secondary Railways (Die Wahl der Spurweite bei Lokalbahnen). E. A. Ziffer. An address containing a general discussion of the best gauge for tracks under various circumstances. 4500 w. Mitt d Ver f d Förderung d Lokal u Strassenbahnwesens—June, 1903. No. 56194 D.

Norfolk & Western.

The Norfolk & Western Railroad. George L. Fowler. The present physical condition and its operation is discussed in the present article. 3000 w. Ill. R R Gaz—July 3, 1903. Serial. 1st Part. No. 56552.

Rails.

Tests of Unit Fiber Strains in the Base of Rails. P. H. Dudley. Presented before the Am. Soc. for Test. Materials. Gives tabulated stremmatograph tests. and an interesting discussion of track construction and related subjects. 5000 w. Ry Age—July 24, 1903. No. 56827.

Results Observed Upon the Philadelphia & Reading Ry. in Connection with Inspection of Steel Rails. Robert Job. Presented at meeting of the Am. Soc. for Test. Materials in discussion of report on Specifications for Steel Rails. Ill. 1000 w. Eng News—July 16, 1903. No. 56751.

Shops.

Milwaukee Shop Improvements of the Chicago, Milwaukee & St. Paul. An illustrated description of the modernization and enlargement of this important plant, with rearrangement and extensive increase of yard tracks. 3500 w. R R Gaz—June 26, 1903. No. 56450.

The New Shops of the American Locomotive Company at Schenectady. Lindsay Duncan. Illustrates and describes the design and construction of important additions to the plant at Schenectady, the transportation arrangements, power distribution, etc. 3500 w. Eng Rec—June 27, 1903. No. 56449.

Signalling.

Automatic Signalling. William John Cudworth. Read at the Engng. Con. of the Inst. of Civ. Engrs. Discusses the various systems of automatic working that have been tried. Ill. 1000 w. Engng—June, 1903. No. 56317 A.

Automatic Signal-Protection for Milwaukee Passenger Station, Chicago, Milwaukee and St. Paul Railway. An illustrated description of a recently installed system to protect the five tracks under the train-shed of the passenger station. 2000 w. Ry Age—July 3, 1903. No. 56516.

Normal Clear vs. Normal Danger Automatic Block Signal Systems. Discusses the merits of the two systems, and suggests that enginemen be required to observe the signal operate. 1800 w. Ry Age—July 17, 1903. No. 56782.

The "Crewe" System of Electrically-Operated Points and Signals. Illustrated detailed description. 3200 w. Engng—July 17, 1903. No. 56820 A.

The Distant Signal. H. Raynar Wilson. A letter explaining British practice, and points of difference from American practice. 2300 w. R R Gaz—July 24, 1903. No. 56847.

The Evolution of Railroad Signaling. Charles Hansel. Historical review, with statement of the writer's views on the best practice. Editorial note. 4000 w. R R Gaz—July 10, 1903. No. 56649.

The Taylor Electric Signal System at the Railway Station of Pétange, Luxemburg (Note sur les Postes Electriques, Système Taylor, de la Gare de Pétange, Grand Duché de Luxembourg). M. Collot. Illustrated description of an interlocking switch and signal system at an important railway junction. 1 Plate. 1800 w. Rev Gén Chemins d Fer—June, 1903. No. 56940 H.

Ties.

The Cutting and Laying of Ties. Herman von Schrenk. The importance of laying the tie so that the convex side of the annular rings is on the upper side. Ill. 600 w. R R Gaz—July 17, 1903. No. 56756.

The Seasoning of Tie Timber. Herman von Schrenk. From the Bureau of Forestry Bulletin, No. 41. On the treatment and processes of preservation, etc. 2800 w. R R Gaz—July 3, 1903. Serial. 1st part. No. 56550.

Turntable.

See Electrical Engineering, Power Applications.

Winter Construction.

Methods for Winter Railway Location and Construction. E. H. Drury. Descriptive notes of methods used in locating and building railways in mid-winter in a northern bush country, where the thermometer is sometimes 40 degrees below zero. 2000 w. Eng Rec—July 4, 1903. No. 56544.

TRAFFIC.

Tonnage.

Effects of Tonnage Ratings on the Cost of Transportation. C. H. Quereau. Read before the Mas. Mechs.' Assn. Showing savings and benefits due to the use of tonnage ratings. 3000 w. Ry & Engng Rev—June 27, 1903. No. 56462.

MISCELLANY.

Brushes.

Brush Specifications, Long Island Railroad. A copy of these novel specifications. Ill. 1200 w. R R Gaz—June 26, 1903. No. 56455.

Government Ownership.

Government Ownership of Railways. H. R. Meyer. The first of a series of articles aiming to give the facts regarding the experience of Europe and Australasia in the adjustment of railway rates and management of the railways. 4000 w. Ry Age—July 10, 1903. Serial. 1st Part. No. 56647.

Legislation.

Railroad Legislation in Connecticut. Clarence Deming. An outline of the present situation in the Connecticut legislature in regard to electric and steam railroads. 1800 w. R R Gaz—June 26, 1903. No. 56452.

Standards.

Correct Railroad Standards. W. H. Sheasby. Prize paper, read before the Pacific Coast Ry. Club. A criticism of some railroad practices and methods. 4000 w. Ry Age—July 3, 1903. No. 56-515.

STREET AND ELECTRIC RAILWAYS

Accumulator Traction.

The Application of Accumulators in Transportation (Die Verwendung des Akkumulators in der Verkehrstechnik). Dr. Max Büttner. A paper before the Verein Deutscher Maschinen-Ingenieure, giving an illustrated account of the use of storage batteries in power stations, and on cars, locomotives, cranes, automobiles, etc. 10000 w. Glasers Annalen—June 15, 1903. No. 56241 D.

See also Electrical Engineering, Generating Stations.

Berlin.

Local Passenger Traffic in Berlin (Der Berliner Lokalverkehr). A general discussion of the local transportation problem in Berlin, and of existing and projected means of travel. 2500 w. Ill Zeitschr f Klein u Strassenbahnen—July 1, 1903. No. 56192 C.

Brakes.

Power Brakes in St. Louis. R. P. Garrett. Explains the conditions in St. Louis which led to the requiring all street cars to be equipped with power brakes, and illustrates two of the makes approved by the Board of Public Improvements. 900 w. R R Gaz—July 24, 1903. No. 56849.

An Emergency Track Brake Used by the United Railroads of San Francisco. Describes the conditions in San Francisco which made necessary a brake that would stop cars on heavy grades, and gives an illustrated description of the brake designed by G. W. Douglas, now in successful use. 1300 w. St Ry Jour—July 4, 1903. No. 56532 D.

British Railways.

The Electrification of British Railways. Reviews briefly what has been accomplished on the continent of Europe, and discusses the peculiar features of the problem in Great Britain. Maps. 5800 w. St Ry Jour—July 4, 1903. No. 56531 D.

Brooklyn.

The New Third Avenue Station of the Brooklyn Rapid Transit Co. Arthur L. Rice. An illustrated detailed description of the building construction of this new station and its equipment. 3000 w. Engr, U S A—July 15, 1903. No. 56740 C.

Car Seating.

The Suburban Car Seating Problem. Describes the four plans of seat arrangement being considered by the Illinois Central R. R. 900 w. Loc Engng—July, 1903. No. 56412 C.

Census.

The Census Report on the Street Railway Industry. Reviews this report, giving details of interesting statistics. 1800 w. St Ry Jour—July 11, 1903. No. 56-626 D.

Chicago.

Proposed Inner Circle System for Chicago. Illustrated description of a plan by A. S. Robinson, which consists of one inner circle or loop subway, upon which cars will move only in one direction, acting as a transfer and stopping at all stations. 1200 w. St Ry Jour—July 11, 1903. No. 56625 D.

Cleveland Interurban.

Improvements on the Cleveland & Southwestern Interurban System. An illustrated article reviewing this system and describing recent construction and equipment. 3000 w. St Ry Jour—June 27, 1903. No. 56436 D.

Comparison.

Comparative Cost and Advantages of the Underground Conduit and the Overhead Trolley Systems. A report by Messrs. Maurice Fitzmaurice and Alfred Baker, presented to the London County Council. 3300 w. Tram & Ry Wld—June 11, 1903. No. 56344 B.

Electric Locomotives.

Electric Mining Locomotives and Auxiliary Machinery. Frank C. Perkins. States the special advantages of their use for haulage and gives information of types used in various mines. 1000 w. Min Rept—July 16, 1903. Serial. 1st Part. No. 56778.

Electro-Pneumatic.

A Single-Phase Electric Railway with Pneumatic Acceleration (Einphasenbahn mit Pneumatischer Beschleunigung). W. A. Blanck. An illustrated brief description of the B. J. Arnold system of single-phase electric and compressed-air traction. 1000 w. Elektrotech Zeitschr—July 16, 1903. No. 56261 B.

Elevated Railways.

Elevated Railways. Gerald Barker. Considers some of the advantages claimed for the deep-level tube railways, the railways in shallow subways, the tramways on the surface, and elevated railways. Also considers the disadvantages that have been alleged against these systems. Ill. 3300 w. Engng—July 24, 1903. No. 57024 A.

Energy Losses.

Energy Losses on Electric Cars. W. Park. Gives diagrams showing the distribution of the losses on an electric car, and suggests ways of effecting increased running efficiency. 1400 w. Tram & Ry Wld—June 11, 1903. No. 56343 B.

England.

English Interurban Line. Illustrates and describes an interesting electric railway, recently completed, extending from the outskirts of Portsmouth to Horndean. 2200 w. St Ry Jour—June 27, 1903. No. 56427 D.

European Tramways.

Notes on European Tramways. Richard McCulloch. General observations of an engineer engaged in the examination, construction, and operation of tramways, traveling with the view of locating tramway lines. Ill. 8500 w. W Soc of Engrs—June, 1903. No. 56398 D.

Feeder Problems.

Notes on Railway Feeder Problems. William A. DelMar. Treats only of direct-current feeders which supply current to the cars. 2500 w. Am Elect'n—July, 1903. No. 56638.

Fender.

The Kliemann Fender for Street Cars and Automobiles (Die Kliemannsche Schutzvorrichtung für Strassenbahnwagen und Motorfahrzeuge). An illustrated description of a network fender with two pockets, on a frame of iron covered with rubber tubing. 2500 w. Ill Zeitsch f Klein u Strassenbahnen—May 1, 1903. No. 56189 C.

Germany.

Statistics of Electric Railways in Germany, Oct. 1, 1902 (Statistik der Elektrischen Bahnen in Deutschland nach dem Stande vom 1. Oktober, 1902). General statistics of all German electric railways, in operation or under construction, with editorial. Tables. 10000 w. Elektrotech Zeitschr—July 9, 1903. No. 56256 B.

Glasgow.

The Glasgow Municipal Tramway System. Historical descriptive account of this very successful undertaking, with illustrations and maps. 4500 w. Tram & Ry Wld—July 9, 1903. No. 56690 B.

Hartford.

Hartford Street Railway Co. An illustrated article describing additional power generating facilities and new car house at Hartford, Conn. 4800 w. St Ry Rev—July 20, 1903. No. 56781 C.

High-Speed.

I. High-Speed Electric Traction on Railways. J. W. Jacomb-Hood. II. The Position and Protection of the Third-Rail on Electric Railways. William E. Langdon. Two papers read at the Engng. Con. of the Inst. of Civ. Engrs. and discussed together. 4800 w. Elect'n, Lond—July 3, 1903. No. 56570 A.

Holiday Traffic.

Holiday Traffic on Tramways. L. E. Harvey. Discussing the question of how far it pays to keep extra cars especially for holiday and week-end traffic in England. 1200 w. Elec Rev, Lond—July 10, 1903. No. 56716 A.

Incline Railway.

Mount Beacon Incline Railway. Illustration, with brief description of a recently built railway up the steep face of one of the Fishkill mountains, near Matteawan, N. Y. 1000 w. Sci Am Sup—July 25, 1903. No. 56797.

Milford, Mass.

Milford Street Railway System. An illustrated description of a road interesting on account of the peculiar situation in reference to the territory covered and the steam roads in that section. 1500 w. St Ry Jour—July 25, 1903. No. 56832 D.

Motors.

Electric Railway Motors (Der Elektromotor als Eisenbahnmotor). Dr. F. Niethammer. A classification and review of the different systems of electric traction and a discussion comparing the direct-current motor very favorably with the polyphase motor. Serial. 2 Parts. 6000 w. Zeitschr f Elektrotech—June 14 and 21, 1903. No. 56262 each D.

Ventilating Railway Motors. Illustrates and describes a plan for ventilating and cleaning railway motors while in operation in regular commercial service. Natural draft is used. Reports tests. 1000 w. St Ry Jour—July 25, 1903. No. 56833 D.

See also Electrical Engineering, Power Applications.

Mountain Railway.

An Electric Mountain Railway in Southern California. An illustrated description of the interesting railway from Los Angeles to the summit of Mount Lowe. 1200 w. Tram & Ry Wld—June 11, 1903. No. 56341 B.

New York.

The Transportation Problem in New York City. Charles Prelini. Considers the difficulties arising from the peculiar configuration of Manhattan Island; the defective plan originally outlined for the city; the great masses that have to be simultaneously handled during the rush hours: and the extraordinary increase in the population. 2800 w. Trac & Trans—July, 1903. No. 56723 E.

Open Car.

Open Elevated Motor Car—Brooklyn Heights Railroad. An illustrated detailed description. 600 w. R R Gaz—July 3, 1903. No. 56551.

Paris Metropolitan.

A General Study of the Metropolitan Railway of Paris (Etude Générale sur le Chemin de Fer Métropolitain de Paris). E. de Loyselles and L. Perreau. A long historical and descriptive review. Serial. Part I. 1000 w. Rev Technique—May 25, 1903. No. 56922 D.

The Paris Metropolitan Railway. A summary of the work, with a description of the principal features of the viaduct is given in the present article. Ill. 3500 w. Engr, Lond—July 10, 1903. Serial. 1st part. No. 56697 A.

The Paris Metropolitan Electric Railway. Daniel Bellet. An illustrated detailed description of the construction work, the difficulties met, etc., with report of the success of the portion of the road in operation. 5600 w. Trac & Trans—July, 1903. No. 56725 E.

Power Stations.

See Electrical Engineering, Generating Stations.

Safety Device.

Electric Train Safety Device. E. C. Parham. Illustrates and describes an automatic device that will not only interrupt the motive power in case of accident, but will also apply the brake. 1400 w. Am Elect'n—July, 1903. No. 56636.

Sault Ste. Marie.

Transportation Facilities at the Soo. An illustrated description of the street railway lines both in Michigan and Ontario, at this point. 1600 w. St Ry Jour—July 4, 1903. No. 56530 D.

Shallow Tunnels.

Shallow Tunnel Railways and the Law. W. Valentine Ball. Discusses some of the legal difficulties that promoters of shallow tunnel railways in England would encounter. 2000 w. Trac & Trans—June, 1903. No. 56303 E.

Single-Phase Motor.

See Electrical Engineering, Power Applications.

Station Indicators.

Station Indicators for Subway, Elevated and Other Railway Systems. Ernest K. Adams. Brief illustrated descriptions of a number of mechanical and electrical station indicators that seem adapted to the uses named. 2000 w. Elec Wld & Engr—July 11, 1903. No. 56639.

Stray Currents.

The Return Circuits of the Hamburg Electric Railways (Rückleitungsnetz der Elektrischen Strassenbahnen in Hamburg). S. Freiherr v. Gaisberg. A paper before the Verband Deutscher Elektrotechniker, giving an account of the measures adopted to prevent the electrolysis of pipes in Hamburg, Germany. Map and diagrams. 2000 w. Elektrotech Zeitschr—June 25, 1903. No. 56248 B.

Surveys for Electrolysis and Their Results. D. H. Maury. Read before the Am. Water Wks. Assn. Also editorial. Practical suggestions for determining and mapping the conditions of stray current flow, for the purpose of studying the corrosion of underground metal structures by electrolytic action. 6000 w. Eng News—July 23, 1903. No. 56842.

Some Recent Effects of Electrolytic Action Upon Underground Mains and Other Metals. A. A. Knudson. Read at a meeting of the Am. Water Wks. Assn. Considers the law governing return currents of single trolley systems, the passing of current through underground mains, the direction of current, etc. Ill. 3000 w. Am Gas Lgt Jour—July 13, 1903. No. 56646.

Sub-Stations.

See Electrical Engineering, Distribution.

Switzerland.

Electric Railway Between Freiburg-Morat and Anet, Switzerland (Chemin de Fer Electrique de Fribourg-Morat-Anet, Suisse). H. Somach. An illustrated description of a third-rail road, supplied with 750-volt direct current from rotary sub-stations. Part of the line was formerly a steam road. 1 Plate. 3000 w. Génie Civil—June 27, 1903. No. 56914 D.

The First Third-Rail in Switzerland. Henri Somach. An illustrated description of the recently constructed third-rail electric railway extending from Fribourg to Morat, near Neuchatel. 1100 w. St Ry Jour—July 25, 1903. No. 56831 D.

Sydney, N. S. W.

The Electric Tramways of Sydney. An illustrated description of the fine system of tramways constructed and maintained by the State of New South Wales. 3000 w. Tram & Ry Wld—July 9, 1903. No. 56689 B.

Texas.

The System of the Northern Texas Traction Company. Map and illustrated description of the interurban line connecting Dallas and Fort Worth, and the local lines of the two places. 6000 w. St Ry Jour—July 18, 1903. No. 56732 D.

Trackless Trolley.

The Trackless Electric Car Line at Grevenbrück, Westphalia (Die Gleitlose Elektrische Bahn bei Grevenbrück in Westf.). Hr. Voiges. An illustrated description of line with double trolley wire and no track. A light electric locomotive hauls two trailers filled with limestone from a quarry to a railway station. 1200 w. Deutsche Bauzeitung—April 18, 1903. No. 56179 D.

Tracks.

Track Construction with Special Reference to Rail Joints. F. H. Davies. Discusses the track construction of the present, gauge, composition of rails, etc., especially jointing of rails and bonds. 3300 w. Elec Engr, Lond—July 10, 1903. No. 56714 A.

Trackways.

See Civil Engineering, Municipal.

Track Welding.

See Electrical Engineering, Miscellany.

United Kingdom.

"Electrical Review" List of Electric Tramways and Railways in the United Kingdom. List and tabulated information. 5500 w. Elec Rev, Lond—June 26, 1903. No. 56481 A.

United States and Canada.

Street and Elevated Railway Mileage, Cars, and Capitalization in the United States and Canada. Table showing the standing for 1902, with remarks. 700 w. St Ry Jour—July 4, 1903. No. 56534 D.

Urban Railways.

The Relative Advantages of Overhead, Deep Level, and Shallow Subway Lines, for the Accommodation of Urban Railway Traffic. S. B. Cottrell. Read before the Engng. Con. of the Inst. of Civ. Engrs. Briefly considers each type. Discussion follows. 2500 w. Engr, Lond—June 26, 1903. No. 56495 A.

Wrexham.

Electric Tramways in Wrexham. An illustrated description of recently completed lines in North Wales, to take the place of horse tramways. 2800 w. Tram & Ry Wld—June 11, 1903. No. 56342 B.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or twelve for $2.00, thirty-three for $5, and one hundred for $15.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.

Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* Philadelphia.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Feilden's Magazine. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Württ. Ver. f. Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Pacific Coast Miner. *w.* San Francisco.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* Chicago.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wiener Bauindustrie Zeitung. *w.* Vienna.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Electrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Engineers' Pocket Book.

Tables and Other Data for Engineers and Business Men. Compiled by Chas. E. Ferris, B. S. Size, 5¾ by 3 in.; pp. 224. Price, 50 cts. Knoxville, Tenn.: University of Tennessee Press.

The primary object of this little book is to bring directly to the attention of men of affairs the value of technical training in schools and colleges, and as a means of reaching the right persons there is here collected a large amount of information useful to engineers and business men, in very compact and convenient form. There are tables of logarithms, areas and circumferences of circles, squares, cubes and reciprocals, iron bars and rods, hydraulics, earthwork, electric wiring, interest, metric conversion, population of cities, and many others. There is information about cement, stonework, machinery, etc., directions for first aid in case of accidents or drowning, and a variety of other useful data. This book is of vest-pocket size and makes a very handy ready-reference work, of value to men of every calling.

Radium.

Radium and Other Radio-Active Substances. By William J. Hammer. Size, 9¼ by 6; pp. viii, 72; illustrations, 41. Price, $1.00. New York. D. Van Nostrand Company.

Almost every day new facts about radioactive substances are being discovered, and new hypotheses of radio-activity advanced, so that even the professional scientist finds it difficult to keep in touch with all the literature accumulating on the subject, while the average layman is apt to be sorely perplexed by what he hears about the many different kinds of rays and sources of radiation. It is, therefore, a very appropriate time for the appearance of Mr. Hammer's book, which collects and coördinates a great deal of information hitherto widely scattered, and illustrates it by many experiments of his own. The text of the book is a reprint of a lecture delivered at a joint meeting of the American Institute of Electrical Engineers and the American Electro-chemical Society, in New York, and the illustrations are largely of apparatus and pictures shown on that occasion. An instructive account of radium and other radio-active substances, such as polonium, actinium and thorium, forms the main part of the book, but there are also interesting and suggestive considerations of phosporescent and fluorescent substances, the properties and applications of selenium, and the treatment of disease by the ultra-violet light. All these subjects are treated in a clear and simple manner, without unnecessary technicalities, and a great deal of very useful and timely information is thus placed at the disposal of a far wider audience than could be reached by the original lecture.

Standard Sections.

British Standard Sections. Issued by The Engineering Standards Committee. Supported by The Institution of Civil Engineers, The Institution of Mechanical Engineers, The Institution of Naval Architects, The Iron and Steel Institute, and The Institution of Electrical Engineers. Size, 15 by 9 in.; pp. 9; figures, 9. Price, paper, $1.00. New York; D. Van Nostrand Company.

The standard sections of structural steel shown in this pamphlet are equal angles, unequal angles, bulb angles, bulb tees, bulb plates, Z bars, channels, beams, and T bars. Each is given a full page, at the top of which is a figure of the section, and below a table, with the dimensions of the different sizes and general remarks. Of the importance of such standardization it is unnecessary to speak, and as these sections have the support of the leading British engineering societies, a knowledge of them is essential to every one concerned with structural work within the confines of the Empire.

BOOKS ANNOUNCED.

Stones for Building and Decoration. By George P. Merrill. Price, $5.00. New York; John Wiley & Sons. London, Chapman & Hall, Ltd.

Telephony. A Manual of the Design, Construction, and Operation of Telephone Exchanges. In Six Parts. By Arthur Vaughan Abbott, C. E. Price per volume, $1.50; per set, $6. New York: McGraw Publishing Co.

News Supplement

The Engineering Magazine—April, 1903

Coming Society Meetings.

Air-Brake Association. Sec.: F. M. Nellis, 174 Broadway, New York. Annual meeting, April 28, Colorado Springs.

American Boiler Manufacturers' Association. Sec.: J. D. Farasey, Cleveland. Next meeting July, at Chattanooga.

American Electrochemical Society. Sec.: C. J. Reed, 929 Chestnut St., Philadelphia. Next meeting, April 16-18, New York.

American Foundrymen's Association. Sec.: Dr. Richard Moldenke, P. O. Box 432, New York. Convention June 9-11, Milwaukee.

American Institute of Electrical Engineers. Sec.: Ralph W. Pope, 95 Liberty St., New York. Annual convention, June 22-26, Niagara Falls. Regular meeting on fourth Friday of each month, 12 W. 31st St., New York. April 24: Papers on Central Station Development.

American Railway Association. Sec.: W. F. Allen, 24 Park Place, New York. Meeting, April 22, 1903, New York.

American Railway Master Mechanics' Association. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 22, etc., Mackinac Island, Mich.

American Railway Mechanical and Electrical Association. Sec.: Walter Mower, Detroit. First annual meeting, Sept. 1-4, Saratoga Springs, N. Y.

American Society of Civil Engineers. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month. Annual convention, June 8, Asheville, N. C.

American Society of Mechanical Engineers. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Semi-annual meeting, June, at Saratoga.

American Street Railway Association. Sec.: T. C. Penington, 2020 State St., Chicago. Annual meeting, Sept. 2-4, Saratoga Springs, N. Y.

American Water-Works Association. Sec.: J. M. Diven, Elmira, N. Y. Annual meeting, June 23-26, Detroit.

Asssociation of Railway Superintendents of Bridges and Buildings. Sec.: S. F. Paterson, Concord, N. H. Annual convention, Oct. 20, Quebec.

Association of Railway Telegraph Superintendents. Sec.: P. W. Drew, Milwaukee. Next meeting, May 13-15, New Orleans.

Boston Society of Civil Engineers. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except January, when on fourth Wednesday.

Canadian Railway Club. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month.

Canadian Society of Civil Engineers. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. Regular meetings every alternate Thursday.

Central Railway Club. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Fridays of Jan., March, May, Sept. and Nov., Hotel Iroquois, Buffalo.

Chicago Electrical Association. Sec.: W. J. Warder, Jr., 900 Warren Ave. Regular meetings on first Friday of each month.

Civil Engineers' Club of Cleveland. Sec.: Arthur A. Skeels, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

Civil Engineers' Society of St. Paul. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

Engineering Association of the South. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

Engineers' Club of Chicago. Sec.: B. W. Thurtell. 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

Engineers' Club of Cincinnati. Sec.: J. F. Wilson, P. O. Box 333. Regular meetings on third Thursday of each month.

Engineers' Club of Columbus (Ohio). Sec.: H. M. Gates, 12½ North High St. Regular meetings on third Saturdays of each month.

Engineers' Club of Minneapolis. Sec.: Edw. P. Burch, 1210 Guaranty Bldg. Regular meetings on third Monday of each month.

Engineers' Club of Philadelphia. Sec.: J. O. Clarke, 1122 Girard Street. Regular meetings on first and third Saturdays of each month.

Engineers' Club of St. Louis. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

Engineers' Society of Western New York.. Sec.: L. W. Eighmy, 13 City Hall, Buffalo. Regular meetings, first Tuesday of each month.

Engineers' Society of Western Pennsylvania. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

Franklin Institute. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month. Regular monthly meetings of the various sections on other days.

International Association of Municipal Electricians. Sec.: Frank P. Foster, Corning, N. Y. Meeting, September, Atlantic City, N. J.

Iowa Railway Club. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

Louisiana Engineering Society. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Mondays.

Master Car Builders' Association. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 17, etc. Mackinac Island, Mich.

Modern Science Club. Sec.: R. Henderson, 302 Livingston St., Brooklyn. Meetings every Tuesday.

Montana Society of Engineers. Sec.: Richard R. Vail, Butte, Mont. Regular meetings on second Saturday in each month.

National Electric Light Association. Sec.: James B. Cahoon, 136 Liberty St., New York. Meeting, May 26-28, Chicago.

New England Railroad Club.. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month at Pierce Hall, Copley Square.

New York Electrical Society. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays.

New York Railroad Club. Sec.: F. M. Whyte, Grand Central Station, N. Y. City. Regular meetings on third Friday of each month except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

North-West Railway Club. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, alternating between Minneapolis and St. Paul.

Pacific Coast Railway Club. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at different cities.

Pacific Northwest Society of Engineers. Sec.: G. F. Cotterill, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

Railway Club of Pittsburg. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month at Hotel Henry.

Railway Signaling Club. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov. Annual meeting, Nov. 10, at Detroit.

Richmond Railroad Club. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursdays.

Roadmasters' and Maintenance of Way Association. Sec.: Chas. McEniry. Cedar Rapids, Iowa. Annual meetng, Oct. 13, 14 and 15, at Kansas City, Mo.

Rocky Mountain Railway Club. Sec.: J. E. Buell, 906 20th Ave., Denver. Regular meetings on first Saturday after the 15th of each month.

St. Louis Railway Club.. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month.

Society of Chemical Industry, New York Section. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, at Chemists' Club, 108 W. 55th Street.

Southern and Southwestern Railway Club. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov.

Technical Society of the Pacific Coast. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

Texas Railway Club. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

Traveling Engineers' Association. Sec.: W. O. Thompson, Oswego, N. Y. Next meeting, Sept. 8, Chicago.

Western Railway Club. Sec.: Jos. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, Auditorium Hotel, Chicago.

Western Society of Engineers. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month.

Personal.

—Dr. George A. Soper, the sanitary engineer, of New York, has visited Ithaca, at the instance of the State Board of Health, and has made recommendations, which the Ithaca Common Council has given him power to carry into effect, for stamping out the recent epidemic of typhoid fever at that place.

—Mr. E. S. Farwell has opened an office at 309 Broadway, New York, for the general practice of his profession as consulting engineer. He is prepared to inspect, test, or design steam power plants, and the heating and ventilating systems of mills and large buildings. Complete electrical plants will be a specialty. His experience as expert steam engineer with the International Paper Company since its organization has furnished exceptional opportunities for the investigation of the many problems peculiar to the paper industry.

—Mr. R. J. Gross, second vice president of the American Locomotive Company, has started on a trip around the world, in the interests of his company. He will visit Japan, Korea, Siam and China, and will then travel via the Trans-Siberian Railway to Russia, and on his way home he will visit nearly every country in Europe. Everywhere his efforts will be directed to extending the market for American locomotives, and to establishing permanent business relations with his company. Mr. C. M. Muchnic, recently mechanical engineer of the Denver and Rio Grande system, and formerly connected with the Brooks Locomotive Works, accompanies Mr. Gross, as secretary.

—Prof. Frederic William Sanders has been appointed to the chair of economics, sociology and modern languages in the Thomas S. Clarkson Memorial School of Technology, at Potsdam, N. Y.

—Mr. C. C. Murray is now connected with the Railway Appliances Company, with headquarters at Pittsburg, giving his time more particularly to the sale of the Q and C pneumatic tools.

—Mr. J. D. Hurley and Mr. A. B. Holmes, formerly connected with the Standard Pneumatic Tool Co., are now associated with the Rand Drill Company in the "Imperial" pneumatic tool department.

—Mr. J. D. Keiley has been appointed assistant electrical engineer, and Mr. E. L. Broome assistant steam engineer of the New York Central and Hudson River Railroad, with offices in New York.

—Mr. Guy W. Buxton, who has been connected for some time with the New York office of the H. W. Johns-Manville Co., has been recently appointed auditor of that company, the branches of which are located in Milwaukee, Chicago, St. Louis, Pittsburg, Cleveland, New Orleans, Boston and Philadelphia.

—Mr. William J. Taylor, of the Taylor Iron and Steel Company, of Highbridge, N. J., died recently at his home in Bound Brook, N. J. He was well known in the iron trade and was a member of the Engineers' Club and other organizations.

—Mr. Charles S. Powell, who has been associated with the Westinghouse electric interests since 1893, and who, for the past six years, has been manager of the Cleveland office of the Westinghouse Electric & Mfg. Company, has changed the scene of his activities from the United States to Europe. He has been appointed assistant manager of the British Westinghouse Electric & Mfg. Company, Limited, and has already entered upon the duties of his new position. Mr. Powell, who was one of the most popular men in the electrical business in the United States, is bound to be equally well liked in Great Britain. His headquarters are in the Westinghouse Building, Norfolk Street, Strand, London, W. C.

—At a meeting of the Fritz Memorial Committee, held in New York, the announcement was made that the four national engineering societies have appointed the following as their representatives on the Board of Trustees of the Fritz Medal: American Society of Civil Engineers—J. James R. Croes, New York; Robert Moore; Alfred Noble, New York; Charles Warren Hunt, New York. American Institute of Mining Engineers—E. E. Olcott, New York; E. G. Spilsbury, New York; James Douglas, New York; Charles Kirchhoff, New York. American Society of Mechanical Engineers—Gaetano Lanza, Boston, Mass.; John E. Sweet, Syracuse, N. Y.; Robert W. Hunt, Chicago, Ill.; S. T. Wellman, Cleveland, Ohio. American Institute of Electrical Engineers—Arthur E. Kennelly, Cambridge, Mass.; Carl Hering, Philadelphia, Pa.; Charles P. Steinmetz, Schenectady; Charles F. Scott, Pittsburgh, Pa. A preliminary organization of the Board of Trustees was effected and a committee was appointed to prepare the way for a permanent organization.

Industrial Notes.

—The exhibition, which is to open at Rheims, France, on May 15, 1903, will contain an important colonial subdivision. A special pavilion is reserved for those European products intended to be exported to the colonies. All applications for information should be directed to the "Administration de l'Exposition," at Rheims.

—The Baldwin Locomotive Works has recently offered to present to the Railway School of Sibley College, Cornell University, a laboratory locomotive of the Vauclain-deGlehn type, especially built to plans to be agreed upon by the Baldwin Locomotive Works and Prof. H. Wade Hibbard. The gift will not be consummated until a building and a testing machine are provided for. The locomotive will be a 4-cylinder balanced compound like the engine built for the Plant System, but with four truck wheels and four driving wheels. The boiler will be designed to carry up to 300 pounds gauge pressure. When the locomotive is run at this pressure the entire weight of the locomotive can be thrown upon the driving wheels by means of a pneumatic cylinder at the rear connected to an anchor in the foundation. When this traction increaser is not used the engine will run at 200 pounds gauge pressure. It is intended to be very easily convertible into a perfectly balanced two cylinder simple engine by the removal of the two high pressure cylinder bushings and a change in the valves. The details of the engine have not as yet been worked out, but are being figured. No work at all has as yet been done on the designing of a testing machine, this awaiting the development of the design of the locomotive, its weight, power, wheel base, etc.

—The Diamond Drill & Machine Co. of Birdsboro, Pa., ran the initial heat of their new steel casting plant on March 7 without a single hitch or blunder; every pound of melted iron was poured into castings, and every casting came out perfect, with not a flaw or defect of any character in any single casting. They expect to run at least one heat a day every day continuously from now on, and are therefore in a position to make immediate and prompt delivery of steel castings. Considering the numerous difficulties encountered, in having their entire foundry destroyed in June, 1902, in which they lost valuable patents, the Diamond Drill & Machine Co., have just cause for congratulation upon the promptness with which they are at present able to supply their steel castings, as well as upon the demonstrated quality of their product.

—The Brown Corliss Engine Co. have increased their capital from $1,000,000 to $1,200,000, in order to have sufficient working capital to handle the great amount of large work on hand and in view.

—For the greater convenience of their numerous customers and to better care for the continued increase of business in New York and vicinity the Weston Electrical Instrument Co., of Waverly Park, Newark, N. J., have opened a New York office at 74 Cortlandt Street. This office will be under the management of Mr. Caxton Brown, who has a theoretical as well as a practical knowledge of the different instruments manufactured by the Weston company and their particular adaptabilities. This will enable any purchaser or any person visiting or doing business in New York who may wish to make inquiries relative to electrical measuring instruments, to come in direct contact with a man who is properly qualified to answer such inquiries. There will be a show room in connection with the New York office in which will be exhibited the different types of Weston instruments and their special advantages, as well as the individual parts which make up the instruments. Besides being a great convenience to customers, the New York office will eliminate much correspondence in the nature of inquiries, thus reducing the time of delivery of orders. A general impression has prevailed that the Weston Electrical Instrument Co., only make voltmeters and ammeters, which is not the case. Having what are credited with being the largest and best equipped works in the world for the production of electrical measuring instruments of all kinds, the company are particularly fitted to turn out work of any special character, in which the highest excellence of mechanical and electrical work and design are the important features. They have in fact been turning out a large amount of special laboratory apparatus for several years past and are now prepared to make standard cells, standard resistances, galvanometers, and the highest grade of special bridge work, speed indicators, etc. The Weston Electrical Instrument Co. extend a cordial invitation to all interested in the subject of electrical measurements to make use of their New York office, either for the purpose of inquiry on the technical points involved or for the prospective purchasing of instruments.

—The offer of the Graton & Knight Mfg. Co., of Worcester, Mass., to send, free of charge, one of their superior oak tanned belts to any manufacturer who would like to test it, is attracting a good deal of favorable attention. The reputation of this fine old house is a guarantee of the excellence of their belting, and that they will in every minutest respect do exactly as they agree.

—It may be of interest to our readers to know that The General Pneumatic Tool Co. recently incorporated, is a re-organization of the business of the machinery department of the Havana Bridge Works, of Montour Falls, N. Y., which has been engaged for some years in the production and sale of improved pneumatic tools. The new corporation will manufacture pneumatic tools, compression riveting machines, pneumatic motor hoists, air compressors, cranes, etc. Extensive improvements in the manufacturing plant have already been made, and an additional building will be erected for a store and engine house, early in the spring. A portion of the new machinery is already in operation, but there are yet to be purchased screw machines, turret lathes, shapers, universal grinders, gear cutters, milling machines, and engine lathes. The tools of this company have received very gratifying recognition, and orders for compression riveting machines, pneumatic hammers, and pneumatic motor hoists, covering the company's capacity for several months, are already booked. Several new types of compression riveting machines have recently been brought out, in addition to those which have been on sale for several years. When all these tools are ready for the market, they will constitute one of the most complete lines of pneumatic machinery handled by any concern in the business.

—The Passaic Rolling Mill Company has been merged with the Passaic Steel Company, the latter company having taken over the entire capital stock of the Passaic Rolling Mill Company in exchange for its own shares. The Passaic Steel Company will continue the business of the Passaic Rolling Mill Company, assuming all of its liabilities and collecting all its assets.

—The Allis-Chalmers Co. will, on May 1st, 1903, remove their general offices from their present location in the Home Insurance Bldg. to the New York Life Bldg., corner of Monroe and La Salle streets, Chicago. This move is only another indication of the progressive spirit which prevails in the management of this strong industrial concern. To give a fair idea of the scope of the business enjoyed by the Allis-Chalmers Co., it may be mentioned that during the past two months orders for either engines, mining machinery, rock-crushing machinery, saw-mill machinery, or flour-mill machinery were booked from every state in the Union, besides the following outside countries: England, South Africa, Mexico, Canada, Chile, Central America, Brazil, West Australia, Turkey, Finland, Yukon Territory, Belgium, British Columbia, Bolivia, Hawaiian Islands, Peru, Alaska, China, and the Philippine Islands.

—The Nernst Lamp Company, of Pittsburgh, having secured patent and selling rights in Canada, are now making arrangements for establishing a factory in the Dominion for the manufacture of their product. This move is not only necessary in order to conform with the Canadian laws of commerce, but is also advisable in order to meet the rapidly increasing demands for this lamp.

—The Philadelphia Pneumatic Tool Co. has arranged to double the size of its offices in New York by renting additional room in the Singer Building, corner of Broadway and Liberty Street. This is made necessary by the greatly increasing business of this company in and around New York City. An electrically-driven air compressor and a complete plant for testing and exhibiting pneumatic tools of all kinds in operation will be installed. The New York offices will continue under the management of Mr. W. A. Battey, assisted by Mr. James H. Beaubien. Orders have been recently received by the Philadelphia Pneumatic Tool Co. for complete equipments of pneumatic tools for the National Railroad of Mexico and for the Interoceanic Railroad of Mexico. In two days last week this company shipped Keller rotary drills to the amount of over $10,000.

—Probably the most important contract for series-alternating equipment that has been awarded within the United States, was recently let by the City of Columbus, Ohio, to the Western Electric Company, of Chicago. This equipment comprises 1,500 series-alternating arc lamps complete, and is to be arranged in twenty 75-light circuits. The contract includes transformers, regulators, and the entire switchboard for the new municipal plant. The most thorough comparison was made between various equipments offered, and it was only after the installation of sample 25-light equipments furnished by several of the competing manufacturers that the contract was awarded. The Western Electric Company have a most thorough, complete, and reliable series-alternating equipment, and are making installations rapidly throughout the country.

—Recent changes in the personnel of the management of the American Tool Works Co., of Cincinnati, have placed the management of the business in the following hands: Mr. Franklin Alter, president; Mr. Henry Luers, secretary and treasurer; Mr. J. B. Doan, general manager; Mr. A. E. Robinson, general superintendent. The month of February resulted in next to the largest month's business in the history of the company. The plant is exceptionally busy in all departments, and the outlook for future business is very bright. Extensive alterations and improvements are now being made, adapted to the company's increasing business. They have just brought out several new tools, embodying the very latest ideas in machine tool construction, and are much gratified at the success attending their introduction.

—The Chicago Pneumatic Tool Company, of Chicago, Ill., report the business prospects in their line decidedly encouraging and state that orders for air compressors and pneumatic machinery of every description continue to pour in with gratifying regularity, not only from all portions of the United States, but from almost every corner of the civilized world, taxing the facilities of their various plants to the utmost to adequately fulfill requirements and indicating clearly the strong hold which their machines have gained in the favor of mechanics everywhere. The business on the Pacific Coast has shown such an astonishing increase that they have decided to appoint Mr. Henry Engels, who has been prominent in the pneumatic tool business for a number of years, as their Western general sales agent on the Coast. Mr. Engels will have his headquarters with Messrs. Eccles & Smith, 91 Fremont Street, San Francisco, Cal., and all Pacific Coast business will be promptly and properly taken care of from this point. Messrs. Eccles & Smith still continue in their capacity as general agents of the company, and in conjunction with Mr. Engels, form a combination which will undoubtedly result to the mutual benefit of both the Chicago Pneumatic Tool Company and their numerous patrons.

—The New York Continental Jewell Filtration Co. have recently received orders from the Khedive of Egypt to install a system of Jewell gravity filtration for the royal palaces at Mantaya, near Alexandria; from Cornell University for a water-purifying plant; from the Columbus Water Works Co., Columbus, Ga., for a Jewell gravity filter plant of 2,000,000 gallons daily capacity for the city water supply; and for water-purifying plants from the Royal Hungarian Railroad, Klausenberg, Hungary; John J. Campbell, Philadelphia; and the Mutual Life Ins. Co., Cape Town, South Africa.

—The Electrical Engineering course at Union College, Schenectady, N. Y., has been reorganized under the immediate direction and supervision of Prof. Charles P. Steinmetz, the head electrical expert engineer of the General Electric Co., the largest electrical manufacturing company in the world. The conditions here for an electrical engineering school are unusually favorable, and we may say superior to any in the country, due to the old and well-established reputation of the college in engineering education, and the proximity and favorable disposition of the General Electric Co. In the works of the General Electric Co. the student is afforded chances to see and familiarize himself with apparatus and receive information which no other electrical engineering school can offer. Again, in the works of the General Electric Co., which are open to students, Union College has an electrical laboratory vastly greater than the electrical laboratories of all the colleges of the world combined. The complete course will be published shortly in the University catalogue, so it may be sufficient here to say that it will give a thorough grounding in the fundamental principles and their application to all branches of electrical engineering, such as will enable the graduate rapidly to acquire the practical experience necessary to electrical engineering success. A post-graduate course in electrical engineering has been established, which will give advanced instruction, comprising many subjects, which, while of fundamental importance in the modern development of electrical engineering, are not taught by any college, and even hardly published yet. It is such knowledge which establishes engineering reputations.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Asbestos.

Catalogue, with illustrations, descriptions and prices of asbestos materials for a great variety of purposes, notably fireproofing and heat-insulating, and combined with magnesia for steam-pipe and boiler coverings. 7 by 5 in.; pp. 30. C. W. Trainer Mfg. Co., Boston, Mass.

Brass and Iron Goods.

Cloth-bound book, with illustrations, descriptions and price lists of brass and iron goods and pipe and pipe fittings for steam, water and gas, such as valves, cocks, gauges, steam traps, lubricators, etc.; metals, bells, gongs and bell fittings. 7 by 10 in.; pp. 300. Also, illustrated catalogue and price list of pumping and hydraulic machinery for every variety of service. 6½ by 10 in.; pp. 105. W. T. Garratt & Co., San Francisco.

Belt Dressing.

Cloth-bound booklet entitled "Cling-Surface and Belt Management," by John E. Powers, M. A., devoted to an account of Cling-Surface, an application for belting which causes the belt to cling to its pulley without sticking, and a general discussion of belt management, with illustrations of remarkably slack belts which have been treated with Cling-Surface. 7¼ by 4¾ in.; pp. 72. Cling-Surface Mfg. Co., Buffalo.

Carbonizing Coating.

Pamphlet entitled "Hitch Your Wagon to a Star," containing a discussion of the merits of various protective paints and coatings for iron and steel, and, particularly, of Carbonizing Coating, with illustrations of many buildings, bridges and other structures to which it has been successfully applied. 11 by 8 in.; pp. 27. Also, small folder, devoted to Carbonizing Coating. Goheen Manufacturing Co., Canton, O.

Cement Machinery.

Catalogue No. 15, sixth edition, with illustrations and descriptions of rotary kilns, rock and ore breakers, screens, crushing, grinding and pulverizing machines, elevating and conveying machinery, and other kinds of machinery for the modern manufacture of Portland cement. 9 by 6 in.; pp. 72. Allis-Chalmers Co., Chicago.

Drawing Materials.

Catalogue for 1903, 31st edition, with illustrations, descriptions and prices of all kinds of drawing materials and instruments, mathematical instruments and surveying instruments, and useful information and data. 9 by 5½ in.; pp. 491. Keuffel & Esser Co., New York.

Dynamos.

Booklet No. 31, with illustrations and descriptions of direct-current generators of various sizes and types, built for steady and economical service. 6¼ by 3½ in.; pp. 8. Northern Electrical Mfg. Co., Madison, Wis.

Electric Hoists.

Catalogue No. 0225, with illustrations and descriptions of electric hoists for manila or wire rope, in many sizes and for a great variety of purposes. 9¼ by 6¾ in.; pp. 16. Also, pamphlet No. 0228, a booklet devoted to electric hoists. C. W. Hunt Co., West New Brighton, Staten Island, N. Y.

Elevators.

Pamphlet, with illustrations and descriptions of direct-acting hydraulic plunger elevators, for both passenger and freight service, some of which have over 200 feet travel and speeds of from 500 to 600 feet per minute. Also, illustrations of buildings where these elevators are installed. 9 by 4 in.; pp. 15. Plunger Elevator Co., Worcester, Mass.

Finished Castings.

Folder, with illustrations and descriptions of finished castings, which look like machined pieces and are all ready to use. 11 by 8½ in.; pp. 4. H. H. Franklin Mfg. Co., Syracuse, N. Y.

Fire-Extinguishing Supplies.

Cloth-bound catalogue, with illustrations, descriptions and prices of wrought, cast-iron and brass pipe, fitings for steam, water and gas, automatic sprinkler hydrant systems, steam and hot water heating, boiler and engine connections, pumps, hydrants and Grinnell automatic sprinklers. 7½ by 5½ in.; pp. 384. General Fire Extinguisher Co., Providence, R. I.

Gasoline Engines.

Catalogue No. 17, with descriptions and illustrations of gas and gasoline stationary, portable, hoisting and pumping engines, geared base pumpers, mine locomotives and air compressors, in various types and sizes, and for many kinds of service. 6 by 9 in.; pp. 72. Weber Gas & Gasoline Engine Co., Kansas City, Mo.

Graphite.

"Graphite," volume v, number 4, a publication issued in the interest of Dixon's graphite productions, and for the purpose of establishing a better understanding in regard to the different forms of graphite and their respective uses. 11¾ by 9 in.; pp. 8. Joseph Dixon Crucible Co., Jersey City, N. J.

"Hydro-Carbon" System.

Pamphlet, with description of the "Hydro-Carbon" system for boiler furnaces, which increases power, saves fuel and prevents smoke by supplying heated air and hydrogen gas (from dissociated steam) to the fire chamber in special ways. Also, illustrations of stationary and marine plants where this system is in use, and testimonials. 6 by 9½ in.; pp. 32. Steam Boiler Equipment Co. of N. Y., Inc., 20 W. Houston St., New York.

Jacks.

Catalogue D, with illustrations, descriptions and prices of Barrett track jacks, automatic lowering jacks, car and car-box jacks, differential screw jacks, oil-well jacks, pipe-forcing jacks, automobile jacks, motor-armature lifts, and traversing jack bases. 8¾ by 5¾ in.; pp. 48. The Duff Manufacturing Co., Pittsburg.

Locomotives.

"Record of Recent Construction," No. 40, containing a reprint of a paper by W. J. McCarroll, read before the Traveling Engineers' Association, on the "Proper Handling of Compound Locomotives," with illustrations. 6 by 9 in.; pp. 16. Baldwin Locomotive Works, Philadelphia.

Machine Tools.

Catalogue, with descriptions and half-tone illustrations of hollow-hexagon and other styles of turret lathes, vertical turret machines, turret screw machines, valve-milling machines, automatic boring and tapping machines, key lathes, cock grinders, cutting-off machines, boring machines and other kinds of high-grade machine tools, and their attachments. 9 by 6 in.; pp. 59. The Warner & Swasey Co., Cleveland.

Mining Machinery.

Catalogue No. 15, a very large, cloth-bound book, with illustrations, descriptions and price lists of engines, boilers and feed-water heaters; hoisting engines; pumps, water wheels and hydraulic machinery; assayers' supplies; electrical machinery; iron and wood-working machinery; tools and other kinds of mining, milling and smelting machinery and supplies. Also, ready reference tables and useful information, and index. 10½ by 7½ in.; pp. 891. The Mine and Smelter Supply Co., Denver, Colo.

Oil Engines.

A pamphlet, with illustrated descriptions of the Secor oil engine, which uses kerosene oil, and Secor automatic oil-electric machines, in which oil engine and dynamo are combined in a self-contained unit. 9 by 6 in.; pp. 26. The General Power Co., New York.

Pneumatic Tools.

Catalogue, with illustrations and descriptions of pneumatic hammers, holder-on, rotary drills, riveting machines, foundry rammers, and other Keller pneumatic tools and their aplications. 6 by 9¼ in.; pp. 31. Philadelphia Pneumatic Tool Co., Philadelphia.

Punches and Shears.

Catalogue No. 5, with illustrations and descriptions of Werner's patent portable punching and shearing machoines for hand power, and Johns patent punching and shearing machines for belt power, all made of wrought iron and steel; and also adjustable roller trestles. 6¾ by 10½ in.; pp. 56. Henry Pels & Co., 66-68 Broad St., New York.

Railway.

Pamphlet entitled "Modernizing a Trunk Line," being a story of the permanent improvements on the Lackawanna Railroad since 1899, reprinted from the *Railroad Gazette*, with illustrations of bridges, stations and other work. 5 by 7 in.; pp. 30. Delaware, Lackawanna & Western Railroad Co., New York.

Rolling Doors.

Large pamphlet, with descriptions and illustrations of steel rolling doors, shutters and partitions for freight houses, round houses, warehouses, piers, shops, car sheds, factories, dry kilns, office buildings, stores, schools, churches, elevator shafts, and wherever fire protection and convenience are considered. 7¾ by 11 in.; pp. 13. The Columbus Steel Rolling Shutter Co., Columbus, Ohio.

Shaper.

Circular, with illustrated description of a vertical draw stroke shaper especially adapted for machining such work as cannot readily be handled on an ordinary planer or the regular type of shaper, and wherever it is necessary to remove heavy chips from the toughest metals. 9 by 6 in.; pp. 6. Colburn Machine Tool Co., Franklin, Pa.

Ship Log.

Pamphlet, with illustrated description of a log for indicating and recording the speed of vessels. A tube projects through the bottom of the ship, and the pressure due to the speed causes the water in the tube to rise to a height proportional to the speed of the vessel. Suitable floats in the tube are directly connected with the registering mechanism. 7½ by 5 in.; pp. 21. Also, pamphlet with testimonials. Nicholson Ship Log Co., Cleveland.

Steam Engines.

Booklet, with illustrations and descriptions of automatic steam engines of various types: center-crank horizontal, side-crank horizontal, center-crank upright, marine-type upright. 3½ by 6½ in.; pp. 12. The Buffalo Forge Co., Buffalo, N. Y.

Supplies.

Catalogue No. 14, bound in flexible cloth, with illustrations, descriptions and prices of general supplies for steam railroads, electric railways, contractors, bridge builders, stone quarries, mines, blacksmiths, saw mills, paper mills, flour mills, cotton mills, elevators, electric-light plants and water works. 9½ by 7 in.; pp. 505. H. Channon Company, Chicago.

Time Register.

Booklet, with illustrations and description of a clock for registering workmen's time by white lines drawn on black paper. 6½ by 3½ in.; pp. 4. Hawley Time Register Co., Syracuse, N. Y.

Tools.

The 1903 edition of this well-known catalogue, containing illustrated descriptions and useful information and data of milling machines, grinding machines, automatic gear-cutting machines, screw machines, cutters, accurate test tools, machinists' tools and many other kinds of fine machine tools and small tools. 5¾ by 3¾ in.; pp. 458. Brown & Sharpe Mfg. Co., Providence, R. I.

News Supplement

The Engineering Magazine—May, 1903

Coming Society Meetings.

American Boiler Manufacturers' Association. Sec: J. D. Farasey, Cleveland. Next meeting July, at Chattanooga.

American Foundrymen's Association. Sec.: Dr. Richard Moldenke, P. O. Box 432. New York. Convention June 9-11, Milwaukee.

American Institute of Elecrtrical Engineers. Sec.: Ralph W. Pope, 95 Liberty St., New York. Annual convention, June 29-July 3, Niagara Falls. Regular meeting on fourth Friday of each month, 12 W. 31st St., New York. May 19: Papers on Induction Generators.

American Park and Outdoor Art Association. Sec: C. M. Robinson, Rochester, N. Y. Annual meeting, July 7-9, at Buffalo.

American Railway Master Mechanics' Association. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 17, etc., Mackinac Island, Mich.

American Railway Mechanical and Electrical Association. Sec.: Walter Mower, Detroit. First annual meeting, Sept. 1-4, Saratoga Springs, N. Y.

American Society of Civil Engineers. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month. Annual convention, June 8, Asheville, N. C.

American Society of Mechanical Engineers. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Semi-annual meeting, June 22-26, at Saratoga.

American Street Railway Association. Sec.: T. C. Penington, 2020 State St., Chicago. Annual meeting, Sept. 2-4, Saratoga Springs, N. Y.

American Water-Works Association. Sec.: J. M. Diven, Elmira, N. Y. Annual meeting, June 23-26, Detroit.

Association of Railway Superintendents of Bridges and Buildings. Sec.: S. F. Paterson, Concord, N. H. Annual convention, Oct. 20, Quebec.

Association of Railway Telegraph Superintendents. Sec.: P. W. Drew, Milwaukee. Next meeting, May 13-15, New Orleans.

Boston Society of Civil Engineers. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except January, when on fourth Wednesday.

Canadian Railway Club. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month.

Canadian Society of Civil Engineers. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. Regular meetings every alternate Thursday.

Central Railway Club. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Fridays of Jan., March, May, Sept. and Nov., Hotel Iroquois, Buffalo.

Chicago Electrical Association. Sec.: W. J. Warder, Jr., 900 Warren Ave. Regular meetings on first Friday of each month.

Civil Engineers' Club of Cleveland. Sec.: Arthur A. Skeels, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

Civil Engineers' Society of St. Paul. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

Engineering Association of the South. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

Engineers' Club of Chicago. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

Engineers' Club of Cincinnati.. Sec.: J. F. Wilson, P. O. Box 333. Regular meetings on third Saturday of each month.

Engineers' Club of Columbus (Ohio). Sec.: H. M. Gates, 12½ North High St. Regular meetings on third Saturday of each month.

Engineers' Club of Minneapolis. Sec.: Edw. P. Burch, 1210 Guaranty Bldg. Regular meetings on third Monday of each month.

Engineers' Club of Philadelphia. Sec.: J. O. Clarke, 1122 Girard Street. Regular meetings on first and third Saturdays of each month.

Engineers' Club of St. Louis. Sec.: H. J. Pfeifer, 920 Rialto Bldg, Regular meetings on first and third Wednesdays of each month.

Engineers' Society of Western New York. Sec.: L. W. Eighmy, 13 City Hall, Buffalo. Regular meetings, first Tuesday of each month.

Engineers' Society of Western Pennsylvania. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

Franklin Institute.. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month. Regular monthly meetings of the various sections on other days.

International Association of Municipal Electricians. Sec.: Frank P. Foster, Corning, N. Y. Meeting, September, Atlantic City, N. J.

Iowa Railway Club. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

League of American Municipalities. Sec.: John MacVicar, Des Moines, Iowa. Seventh annual convention, Oct. 7-9, at Baltimore.

Louisiana Engineering Society. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

Master Car Builders' Association. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 22, etc. Mackinac Island, Mich.

Modern Science Club. Sec.: R. Henderson, 302 Livingston St., Brooklyn. Meetings every Tuesday.

Montana Society of Engineers. Sec.: Richard R. Vail, Butte, Mont. Regular meetings on second Saturday in each month.

National Electrical Contractors' Association of the United States. Sec.: W. H. Morton, Utica, N. Y. Next meeting, July 15-17, at Detroit.

National Electric Light Association. Sec.: James B. Cahoon, 136 Liberty St., New York. Convention, May 26-28, Chicago.

New England Railroad Club.. Sec.: Edw. L. Janes, Back Bay, P. O., Boston. Regular meetings, second Tuesday in each month at Pierce Hall, Copley Square.

New York Electrical Society. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays.

New York Railroad Club. Sec.: F. M. Whyte, Grand Central Station, N. Y. City. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

North-West Railway Club. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, alternating between Minneapolis and St. Paul.

Pacific Coast Railway Club. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at different cities.

Pacific Northwest Society of Engineers. Sec.: G. F. Cotterill, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

Railway Club of Pittsburg. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month at Hotel Henry.

Railway Signaling Club. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov. Annual meeting, Nov. 10, at Detroit.

Richmond Railroad Club. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month.

Roadmasters' and Maintenance of Way Association. Sec.: Chas. McEniry, Cedar Rapids, Iowa. Annual meeting, Oct. 13, 14 and 15, at Kansas City, Mo.

Rocky Mountain Railway Club.. Sec.: J. E. Buell, 906 20th Ave., Denver. Regular meetings on first Saturday after the 15th of each month.

St. Louis Railway Club.. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month.

Society for the Promotion of Engineering Education. Sec.: C. A. Waldo, Purdue University, Lafayette, Ind. Annual convention, July 1-3, at Niagara Falls.

Society of Chemical Industry, New York Section. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, at Chemists' Club, 108 W. 55th Street.

Southern and Southwestern Railway Club. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov.

Technical Society of the Pacific Coast. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

Texas Railway Club.. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

Traveling Engineers' Association. Sec.: W. O. Thompson, Oswego, N. Y. Next meeting, Sept. 8, Chicago.

Western Railway Club. Sec.: Jos. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, Auditorium Hotel, Chicago.

Western Society of Engineers.. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month.

Personal.

—Messrs. Mackenzie and Quarrier have been incorporated under the name of Mackenzie, Quarrier & Ferguson, with offices in the Engineering Building, 114-118 Liberty Street, New York. They will continue to represent the Harrisburg Foundry and Machine Works.

Mr. Thomas P. Egan, president of J. A. Fay & Egan Co., of Cincinnati, the manufacturers of wood-working machinery, was one of the visitors at New Orleans, at the National Association of Manufacturers' meeting, April 14th and 15th. Mr. Egan was the organizer and first president of this association, and he takes great pride in having such a distinction, as this body of men is one of the most influential in the country.

—Messrs. John F. Kelly, Ph. D., W. L. Fairchild and T. W. Kloman, have incorporated under the name of The John F. Kelly Engineering Co., to conduct a consulting and contracting engineering business, with offices in the Singer Building, 149 Broadway, New York. All of these gentlemen have been connected for years with the Stanley Electric Manufacturing Co., Dr. Kelly being one of the inventors and engineers who have designed the famous S. K. C. apparatus, besides having made his mark in a great variety of other electrical work.

—Kilburn, Clark & Company, of Seattle, Wash., have been made the Pacific Coast sales and distributing agents of the Nernst Lamp Company, of Pittsburg, and have established branch offices in San Francisco and Los Angeles, Cal. The increasing volume of business from that section of the country has made necessary special attention to its demands.

—Mr. Edgar N. Smith, formerly roadmaster on the B. & M. R. Railroad in Nebraska, and before that on the N. Y., N. H. & H. Railroad and the Boston Elevated, has accepted a position with the Railway Appliances Company, giving his time particularly to the "Q and C-Bonzano" rail joint.

—Mr. H. Clay Moore, No. 816 Empire Building, Atlanta, Ga., has been appointed sole agent for the south-eastern part of the United States, for the Scaife and We-Fu-Go systems of water softening and purification, manufactured only by Wm. B. Scaife & Sons Co., of Pittsburg, Pa.

—Mr. J. E. Meek, of the Asbestos Department of the H. W. Johns-Manville Co., New York, recently visited Washington and Newport News.

—The directors of the Steam Boiler Equipment Company of New York have elected officers as follows for the ensuing year: President and secretary, E. H. Hovey; vice-president, Wm. McAdoo, former Assistant Secretary of the Navy; treasurer, Dr. P. J. Oettenger, all of New York.

—At the meeting of the council of the Iron and Steel Institute, held recently, it was resolved unanimously that the Bessemer gold medal for this year should be awarded to Sir James Kitson, Bart., M. P., past president, in recognition of his great services to the iron and steel industry of Great Britain. The presentation of the medal will be made by Mr. Andrew Carnegie, at the annual meeting on May 7.

Industrial Notes.

—The Bradley Manufacturing Company, of Pittsburg, have issued a neat and ingenious card which is a working model showing the valve and piston motions of the Willans central-valve compound steam engine, of which they are the American manufacturers.

—Men who use or employ chain blocks will be interested in the offer of the Yale & Towne Mfg. Co. of prizes for information from mechanics concerning Triplex chain blocks. This contest is open to all, practical statements being the only thing required, and not fine writing. There is no question that scientific chain blocks are as much a benefit to the man who pulls the chain as to the one who pays the bills; and any enlightenment on this subject is bound to be eventually profitable to both. Employers ought to call the attention of their foremen and mechanics to this offer.

—The Engineering Agency, Monadnock Block, Chicago, was started in 1893 by Mr. F. A. Peckham, at that time western manager of the "Enginering News." Mr. Peckham found in traveling about the country that he was constantly asked by manufacturers where they could find certain competent help. On the other hand, his office was visited every day by those who thought his paper might be able to assist them to positions. The Agency has grown steadily, and during the past ten years has secured positions for over 5,000 technical men. The registrations during the past two years have exceeded 3,000 and yet to-day the Agency has difficulty in securing enough competent men to supply all of the demands made upon it by companies that wish high-grade help. It is therefore using the "Want" columns of some leading papers throughout the country. Every person who registers in the Engineering Agency is obliged to give a complete record of his past experience and if the Agency thinks that the experience is not satisfactory it refuses to permit the applicant to register; if it does accept the registration fee, but finds upon investigating the references that he is not such a man as the Agency wishes to recommend, it returns to him promptly the registration fee. The care taken to register only competent men and to recommend always the right man for the right place, together with an experience of ten years with the leading railways, manufacturing and industrial companies, enables the Agency to secure positions promptly for almost any high-grade technical man who can furnish a good record and references. Mr. F. A. Peckham, president of the Agency, was for twelve years with the "Engineering News"; Mr. A. B. Gilbert, treasurer, has recently completed over eleven years' work for the same paper, during six of which he was assistant manager; Mr. A. G. Frost, secretary, has been connected with the Agency for several years.

—The Westinghouse Air Brake Company will at once begin the erection of a new foundry, to be 320 feet long by 65 feet wide, and constructed of brick with steel frame. This foundry will be located just west of the present Air Brake works at Wilmerding, Pa., and has been made necessary by the greatly increased demand for castings used in the apparatus manufactured by this company. Owing to the development of the traction-brake business, the Air Brake Company's present foundry facilities have been overtaxed for some time past, and in order to insure greater efficiency in production and prompt delivery of material it has become necessary to provide greater capacity. This addition to the plant will materially increase the Brake Company's working force, now numbering about 3,000 men, the majority of whom reside in Wilmerding and vicinity.

—The Engineering School of Union College is one of the oldest technical schools in the country. Founded in 1845 with Prof. Wm. M. Gillespie at its head, it at once took a high rank and for many years was one of the few engineering schools in America. From the first the evident policy of the school was to adapt the thorough training of l'Ecole des Ponts et Chaussées, where Professor Gillespie had finished his technical education, to the demands of professional practice in a vigorous new country where resources and opportunities were abundant, and capital and professional precedent were wanting. From the characteristics impressed on the school at its foundation it has not departed; mathematics, economics, and adaptation may be said to have been the leading subjects in its permanent curriculum. The School has kept pace with the wonderful development in American technical education and in the increasing demands on professional training. For many years engineering only was taught; then when the principles of modern sanitary science came to be better understood, a course in sanitary engineering was established, and more recently the course in electrical engineering, now being greatly extended, was undertaken. During its whole history the school has stood for broad, fundamental training rather than narrow specialization, and during recent years its advanced entrance requirements have made room in the course for them, increased time and attention have been given to culture studies and increased academic training.

—The Brown Corliss Engine Co., of Corliss, Wis., recently received an order from the Middlesex & Somerset Traction Co., of New Brunswick, N. J., for one 16 and 30 by 42 inch horizontal cross-compound engine and one 18 and 34 by 36 inch vertical cross-compound engine, and also received an order from the American Locomotive Co., of Dunkirk, N. J., for one 26 and 42 by 42 inch tandem compound engine.

—About one year ago The Lozier Motor Company, of Plattsburg, N. Y., decided that on account of their large and growing business in the metropolitan district, it would be necessary to establish local headquarters in New York City, and a branch office was opened at No. 1 Broadway. The growing popularity of Lozier gasoline engines and the launches and yachts manufactured by The Lozier Motor Company soon made it apparent that it was necessary to establish local yards and shops to take care of trade in the metropolitan district, and last summer a tract of ground was purchased at Castle Hill Point, at the mouth of Westchester Creek, and work was immediately commenced on a factory with ample facilities to enable The Lozier Motor Company to better care for their local business. This plant has just been put in operation. It is located on a beautiful plot of ground overlooking the Sound. The main building is 200 by 60 feet, and a showroom and warehouse 100 by 40 feet is under process of construction. Marine ways for launches and yachts of all sizes built and equipped by this company are provided. As the principal factories and machine shops of the Lozier Company are situated in Plattsburg, N. Y., on Lake Champlain, the work at the New York City plant will be largely confined to the building of large yachts and the installation of Lozier engines in launches and auxiliary craft; in fact, the primary object of this factory is to look after the interests of the patrons of the company in the vicinity of New York City. While no engines are manufactured at this plant, it is the intention of the company to carry a large stock of motors on hand for immediate delivery, and stock launches of this company can be seen on exhibition at all times, and deliveries made in the water on short notice.

—The Philadelphia Pneumatic Tool Company has secured a contract from the Lake Shore & Michigan Southern Railway Company to supply them with all the pneumatic hammers which they will use in the new Collinwood Shops and on the entire system for a period of one year. This contract is awarded after a competitive test of all the different makes of pneumatic tools. This company has also received large orders for chipping and riveting hammers and drills from the Wabash, the Delaware & Hudson and the Central of New Jersey railroads.

—The New York Continental Jewell Filtration Co. has been awarded a filter contract for the entire city of Ithaca, N. Y., besides the contract recently closed with Cornell University. This company has also received a large order from the Producers' Powder Co., of Ashburn, Mo., for a New York gravity type of filter.

—The Nugent Anti-Packed Telescopic Oiler is designed to lubricate any reciprocating bearing, such as the cross-head pin, eccentrics, and the double-disk crank pin of steam engines, and other similar bearings. The anti-packed joint is the new, novel and improved feature of this invention. The joints are 1-100 of an inch loose and yet not a drop of oil can leak or wast through them. They have no stuffing-boxes, washers or packing of any kind. Thus the friction, wear and jar is practically done away with and consequently the device will outwear the engine or piece of machinery to which it is applied. This oiling device forms a continuous conduit or channel for the oil from the stationary oil cup to the bearing which is to be lubricated. It will about treble the life of the cross-head pin, which usually wears out as fast again as the crank pin. It will save its cost in oil in a short time, over any other appliance, such as the wiper cup or grease cup. It enables the engineer to positively know whether or not the bearing is getting oil and it places the pin or bearing under the absolute control of the engineer at all times and enables him to run his engine continuously for ten years, if necessary, without having to stop to replenish the oil, because the oil cup is always stationary. By simply pulling out two cotter pins with the fingers, the telescopic tubes and head may be removed in a moment's time. The purchaser of this appliance takes no chances whatsoever, for perfect satisfaction is guaranteed and the money will be refunded any time within one year after the date of the purchase, if the oiler does not fulfill expectations.

—The Western Electric Company has bought a tract of land, comprising 109 acres, in the southwestern part of Chicago, where it will erect structures costing $1,200,000, for the manufacture of its products. This location is a very good one, being on Ogden Avenue, one of the main diagonal thoroughfares of the city, and also on two railroads, the Chicago, Burlington & Quincy and the Chicago & Western Indiana Belt Line, the latter making connections with all the other railroads entering Chicago. Plans have been made for cable works, machine shop, iron foundry and a power plant, which will all employ about 1,200 hands. This undertaking is in addition to the present large interests of the Western Electric Co., and will in no way curtail them.

—The American Blower Co. has recently opened an office at 615 Hale Building, Philadelphia, in charge of Mr. Benj. Adams, and another at 318 Frick Building, Pittsburg, in charge of Mr. H. P. Curtiss.

—The A. Leschen & Sons Rope Company, manufacturers of wire rope and aërial wire rope tramways, with headquarters at 920 to 932 North First Street, St. Louis, have just opened an office and warehouse at 1717-1723 Arapahoe Street, Denver, Colo., where they will carry a full stock of their various grades of wire rope, manila rope, etc. This gives them four branch offices and warehouses in addition to their headquarters at St. Louis, viz.: 92 Center Street, New York City; 137 East Lake Street, Chicago; 85 Fremont Street, San Francisco; and the Denver office above referred to. The A. Leschen & Sons Rope Company not only manufacture all of the ordinary grades of wire rope, such as are made by other manufacturers, but they are also the sole manufacturers of the celebrated Hercules colored-strand wire rope and the patent flattened-strand wire rope. They also manufacture automatic tramways which load and unload automatically, several types of friction-grip tramways and single-line and two-bucket tramways.

—A continuation of flourishing business is reported by the Chicago Pneumatic Tool Co., of Chicago, and they are still compelled to work the forces at their various plants both night and day in order to fulfill requirements. This company is continually on the lookout for new devices which fit in with their line of pneumatic appliances of every description, and have within the past few months made several additions which are among the most perfect productions of their kind. The chief of these are a pneumatic hand rock drill, designated as the Chicago rock drill, and a compression riveter, which is called the Chicago compression riveter. These machines, although but very recently placed on the market, have already indicated, by the heavy sales immediately created, that they are up to the high standard demanded of all tools manufactured by the Chicago Pneumatic Tool Company. Both these machines are illustrated and fully described in attractive circulars which the company is mailing to the trade.

The entire business of the Consolidated Machine Specialty Co., including the patents, good-will and machinery of every kind, has been purchased by the Power & Speed Controller Co., of Boston. The business of manufacturing speed-controlling and speed-varying apparatus will be continued, but with new and greatly increased facilities. The factory has been enlarged and the mechanical construction and efficiency of the "Controllers" much improved; all the machines now being placed on the market are very strongly made, have a very high percentage of efficiency and wide range of speed. The Franklin Institute of Philadelphia has just awarded the Edward Longstreth Medal of Merit to this "Controller."

—The Abendroth & Root Mfg. Co., located for more than 30 years at Brooklyn, N. Y., and which was burned out in July, 1901, has now completed in every detail the equipment of its new works at Newburgh, N. Y. The present plant consists of twelve acres with a frontage of nearly 1,000 feet on the Hudson River, is well supplied with dock facilities for export shipment and is located on the main line of the West Shore R. R., which in turn connects with the Newburgh terminal of the N. Y. Central, Erie and New Haven roads. To the west of the railroad track lie the foundry, machine and boiler erecting shops, 100 feet by 400 feet, and the pattern, carpenter and forge shops, 50 feet by 150 feet, while on the river side the spiral-riveted pipe, sheet iron, galvanizing and asphalting departments are contained in a building 200 feet by 200 feet. These buildings are equipped with the latest type of machines for the economical manufacture of their several products—pipes and boilers. First of these comes the Root spiral-riveted pipe, which when double galvanized is claimed to be without equal for exhaust steam, pump suction, the conveying of paper pulp, and for brine circulation, while in the asphalted finish it has for over 30 years proved its superiority for waterworks, irrigation, hydraulic mining and dredging purposes. This company also manufactures the celebrated Root sectional water-tube boilers which are made in units of from 16 to 500 horse-power. These boilers are well and favorably known both in the United States and abroad. Some of the most prominent power plants in this country are equipped with this boiler, among these being the boiler plant of the Baltimore and Ohio Railway tunnel at Baltimore. For isolated plants, especially in mining districts, no more convenient boiler is manufactured. Its design and adaptibility to varied conditions, and transportation to inaccessible places has been demonstrated for over 35 years, no single package weighing over 200 pounds. Its main characteristics are: high economy, rapid circulation, absolute flexibility, perfect suspension, truly sectional construction and efficiency. The A. & R. exhaust heads are also manufactured here.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Automobiles.

Pamphlet with half-tone illustrations and descriptions of Packard gasoline motor cars, their details and their manufacture. 9 by 6 in.; pp. 44. Packard Motor Car Co., Warren, Ohio.

Boiler Cleaner.

Pamphlet with illustrations and description of the Garrigus mechanical boiler cleaner, having a floating skimmer, which removes dirt, impurities and scale-forming matter, and conveys them to a precipitator, from which they are blown off. 9 by 6 in.; pp. 29. Also, booklet and folder devoted to this boiler cleaner. The Mechanical Boiler Cleaner Co., Chicago.

Boilers.

Catalogue, ninth edition, with descriptions and illustrations of the Almy patent sectional water-tube boilers for marine and stationary work, with views of the shops, report of test by Geo. H. Barrus, list of users, and pictures of many yachts and other vessels which have been equipped with these boilers. 5¾ by 8½ in.; pp. 63. Almy Water-Tube Boiler Co., Providence, R. I.

Car Loaders.

Catalogue No. 5, with illustrations and descriptions of the Ottumwa mechanical loader for loading coal, ore, lime, phosphate, sand and any other loose material into box cars, together with views of its operation and descriptions of its parts. 7½ by 9 in.; pp. 50. The Ottumwa Box Car Loader Co., Ottumwa, Iowa.

Centrifugal Pumps.

Catalogue No. 10, revised, with illustrations and descriptions of improved centrifugal pumping machinery, with double-swivel suction and discharge pipes, adapted to a great variety of service. 5¼ by 8 in.; pp. 52. The Lawrence Machine Co., Lawrence, Mass.

Chains.

Pamphlet describing and illustrating silent-running, high-speed chains, with the Morse frictionless rocker joint, for power transmission, and their various applications to pumps, electric motors and other machinery. 9 by 6 in.; pp. 19. Morse Chain Co., Trumansburg, N. Y.

Concentrator.

Catalogue No. 5—E, with illustrations and description of the 1903-model Bartlett table for concentrating ores, and useful information and practical data regarding concentration. 9½ by 6¾ in.; pp. 36. The Colorado Iron Works Co., Denver, Col.

Cutting-Off Machine.

Folder, with illustration, description and specifications of the Cochrane-Bly cold-saw cutting-off machine, of rigid and compact design and with convenient attachments. 9 by 6 in.; pp. 4. Cochrane-Bly Machine Works, Rochester, N. Y.

Drop Hammers.

Catalogue, with illustrated descriptions of drop hammers, equipped with Brett patent steam and compressed-air semi-rotary lifters and with friction board lifters, and of the Brett patent press clutch, together with illustrations of details, sample forgings, and works where these hammers are in use. 6 by 9 in.; pp. 24. E. W. Merrill, Jr., Brooklyn, N. Y.

Electric Apparatus.

Bulletins, supply catalogues, price lists, flyers, instruction book No. 8201, for series-enclosed arc-lamp street lighting systems, and other pamphlets, including an index to bulletins, devoted to electric machinery and apparatus of many kinds. General Electric Co., Schenectady, N. Y.

Electric Driving.

Bulletin No. 33, entitled "Electricity as a Motive Power for Machine Shops," containing an illustrated abstract from an article by William Burlingham, in *Machinery*, on the electrical equipment of the shipbuilding establishment of the Wm. R. Trigg Co., of Richmond, Va. 10 by 7½ in.; pp. 12. Crocker-Wheeler Co., Ampere, N. J.

Electric Machinery.

Bulletins devoted to electric generators and motors of various types, medium and slow speed, open, semi-inclosed and inclosed, and other high-grade electrical machinery. 9½ by 6¼ in. Also, booklet with partial list of installations of power and lighting machinery. Keystone Electric Co., 114 Liberty Street, New York.

Electric Specialties.

Illustrated descriptive catalogue and price list of hotel apparatus, carriage annunciators, burglar alarms, programme clocks, watchman's time detectors, bells, buzzers, gongs, fire alarms, keys, door and window springs, door openers, latches, push buttons, gas lighters, switches, and other electrical specialties. 9 by 6 in.; pp. 140. Edwards & Co., 405-409 East 144th St., New York.

Fan Motors.

Special publication No. 7,006, with illustrated descriptions of electric fans for alternating- and direct-current circuits and of both bracket and desk types, together with illustrations of some of the many adaptations of these fans, 8¼ by 5½ in.; pp. 15. Also, two booklets devoted to fan motors. Westinghouse Electric & Mfg. Co., Pittsburg.

Gas Engines.

Catalogue with descriptions and illustrations of stationary, portable, pumping and hoisting gas and gasoline engines, which will operate with gasoline, naphtha benzine, distillate, crude oils, manufactured gas, natural gas and producer gas. 6 by 9 in.; pp. 32. Witte Iron Works Co., Kansas City, Mo.

Hydraulic Machinery.

Large catalogue (foreign edition), with descriptions and illustrations of hydraulic tools, cranes and machinery, including valves, shears, punches, flanges, presses, bulldozers, intensifiers, riveters, both fixed and portable, jib, tower and gantry cranes, accumulators, and other varieties of hydraulic machinery capable of performing the heaviest kinds of work. 8½ by 10½ in.; pp. 103. Also, large folder devoted to the Mond gas for power and heating, with by-product recovery. R. D. Wood & Co., Philadelphia.

Locomotives.

Record of Recent Construction, No. 41, entitled "Some Notable Trains," with illustrations and descriptions of various types of Vauclain compound locomotives in service hauling fast and heavy trains in different parts of the world. 6 by 9 in.; pp. 36. Baldwin Locomotive Works, Philadelphia.

Lumber Machinery.

Catalogue, with illustrations and descriptions of air cushions for saw-mill carriages, saw-mill cranes, logging-car stakes for holding a load securely and dumping it instantly, and direct-acting steam log loaders. 8 by 10 in.; pp. 16. Kilgore Machine Co., Minneapolis, Minn.

Plastic Metallic Packing.

Folder, illustrating and describing plastic metallic packing for high speeds, high pressures and heavy service on steam hammers, air compressors and pumps and all kinds of steam engines. This packing can be used in any stuffing box and can be applied without disconnecting the piston rod. 6 by 3½ in.; pp. 6. The Hileman-James Co., Pittsburg.

Portable Tools.

Catalogue for 1903, with illustrations and descriptions of portable boring bars, facing arms, facing spiders, valve-seat rotary plaining machines, locomotive-cylinder or dome facing machines, milling machines, crank-pin turning machines, radius planer attachments, eccentric mandrel turning machines, and other portable tools for railway repair shops. 9 by 6 in.; pp. 36. H. B. Underwood & Co., Philadelphia.

Portland Cement.

Book with descriptions of Portland cement and concrete and their manufacture, testing, applications, etc.; lists of users of Vulcanite Portland cement and many illustrations of buildings, bridges and other structures where it is employed. 9½ by 7½ in.; pp. 80. Vulcanite Portland Cement Co., Philadelphia.

Roller Bearings.

Booklet with illustrations and descriptions of roller journal bearings, roller end thrusts, ball end thrusts, roller-bearing axles, worm thrust bearings, taper roller thrust for propeller shafts, roller center and side bearings for trolley and railroad cars, roller-bearing shafting hangers, and other kinds of roller and ball bearings. 3½ by 6¼ in.; pp. 16. Standard Roller Bearing Co., Philadelphia.

Search Lights.

Bulletin No. 2, devoted to projectors and searchlights, with illustrations and descriptions of many types suitable for river and ocean steamers, naval vessels, fire departments, military use, etc. 10 by 7 in.; pp. 16. Also, bulletin No. 3, devoted to photo-engraving electric lamps, for newspaper and other work. Chas. J. Bogue, 213-215 Centre St., New York.

Shaking Grates.

Booklet, with illustrated descriptions of Foster shaking grates for steam boilers, in square, oblong and round styles and in all sizes, and for all kinds of fuel. These grates rest on legs and are entirely independent of furnace walls and boiler front. 7 by 4 in.; pp. 12. F. W. Foster Mfg. Co., 6 Portland St., Boston.

Steam Engines.

Catalogue No. 42, with illustrations and descriptions of portable and stationary, horizontal and vertical steam engines and boilers for agricultural and other uses, grates, smoke connections and stacks, steam and mud drums and other auxiliary apparatus. 6 by 9 in.; pp. 58. Nagle Engine and Boiler Works, Erie, Pa.

Pamphlet with illustrated description and specifications of high-speed, center-crank, automatic cut-off steam engines and their parts. 6 by 9½ in.; pp. 12. Liddell Company, Charlotte, N. C.

Steam Traps.

A novel publication, in the form of a legal document, containing "testimony in the matter of the merits of the Wright emergency steam trap," consisting of letters from users, a "summing up" with an illustrated description of the steam trap, and a thirty-days' trial offer and guaranty. Wright Manufacturing Co., Detroit, Mich.

Transformers.

Pamphlet No. 12, with illustrations and descriptions of transformers, their design, construction, testing and operation, with curves showing regulation, efficiency, etc.; and also an account of methods of doing business and liberal guaranties. 9 by 6 in.; pp. 28. Kuhlman Electric Co., Elkhart, Ind.

Turbines.

Catalogue with illustrated descriptions of Risdon cylinder-gate and register-gate turbines, Alcott high-duty turbines, Woodward governors, iron cases, penstocks, head-gate irons, gearings and harness for water-power plants, together with useful tables and information and list of references. 9 by 6 in.; pp. 120. Risdon-Alcott Turbine Co., Mount Holly, N. J.

Water Softening.

Pamphlet, with half-tone illustrations and descriptions of installations of water softening and purifying apparatus, by which hard water is made soft for all purposes, oil is removed from condensed steam, muddy water is cleaned, and water containing acid is purified. 9 by 6 in.; pp. 22. Industrial Water Co., 126 Liberty St., New York.

NEWS SUPPLEMENT

The Engineering Magazine—June, 1903

American Society Meetings.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION. Sec.: J. D. Farasey, Cleveland. Next meeting July, at Chattanooga.

AMERICAN FOUNDRYMEN'S ASSOCIATION. Sec.: Dr. Richard Moldenke, P. O. Box 432, New York. Convention June 9-11, Milwaukee.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Sec.: Ralph W. Pope, 95 Liberty St., New York. Annual convention, June 29-July 3, Niagara Falls. Regular meeting on fourth Friday of each month, except June, July and August, 12 W. 31st St., New York.

AMERICAN PARK AND OUTDOOR ART ASSOCIATION. Sec.: C. M. Robinson, Rochester, N. Y. Annual meeting, July 7-9, at Buffalo.

AMERICAN RAILWAY ASSOCIATION. Sec.: W. F. Allen, 24 Park Place, New York. Next meeting Oct. 28, at Richmond, Va.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 24-26, Saratoga Springs, N. Y.

AMERICAN RAILWAY MECHANICAL AND ELECTRICAL ASSOCIATION. Sec.: Walter Mower, Detroit. First annual meeting, Sept. 1-4, Saratoga Springs, N. Y.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August. Annual convention, June 8, Asheville, N. C.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Sec.; Prof. F. R. Hutton, 12 W. 31st St., New York. Semi-annual meeting, June 22-26, at Saratoga Springs, N. Y.

AMERICAN SOCIETY FOR TESTING MATERIALS. Sec.: Prof. Edgar Marburg, University of Pennsylvania. Convention July 1, 2 and 3, at the Delaware Water Gap.

AMERICAN STREET RAILWAY ASSOCIATION. Sec.: T. C. Penington, 2020 State St., Chicago. Annual meeting, Sept. 2-4, Saratoga Springs, N. Y.

AMERICAN WATER-WORKS ASSOCIATION. Sec.: J. M. Diven, Elmira, N. Y. Annual meeting, June 23-26, Detroit.

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS. Sec.: S. F. Paterson, Concord, N. H. Annual convention, Oct. 20, Quebec.

BOSTON SOCIETY OF CIVIL ENGINEERS. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

CANADIAN RAILWAY CLUB. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

CANADIAN SOCIETY OF CIVIL ENGINEERS. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. Regular meetings every alternate Thursday, from October to May, inclusive.

CENTRAL RAILWAY CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Fridays of Jan., March, May, Sept. and Nov., Hotel Iroquois, Buffalo.

CHICAGO ELECTRICAL ASSOCIATION. Sec.: W. J. Warder, Jr., 900 Warren Ave. Regular meetings on first Friday of each month, from October to May.

CIVIL ENGINEERS' CLUB OF CLEVELAND. Sec.: Arthur A. Skeels, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

ENGINEERING ASSOCIATION OF THE SOUTH. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

ENGINEERS' CLUB OF CHICAGO. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

ENGINEERS' CLUB OF CINCINNATI. Sec.: J. F. Wilson, P. O. Box 333. Regular meetings on third Saturday of each month, except July and August.

ENGINEERS' CLUB OF COLUMBUS (OHIO). Sec.: H. M. Gates, 12½ North High St. Regular meetings on third Saturday of each month, except July and August.

ENGINEERS' CLUB OF MINNEAPOLIS. Sec.: Edw. P. Burch, 1210 Guaranty Bldg. Regular meetings on third Monday of each month.

ENGINEERS' CLUB OF PHILADELPHIA. Sec.: J. O. Clarke, 1122 Girard Street. Regular meetings on first and third Saturdays of each month, except July and August.

ENGINEERS' CLUB OF ST. LOUIS. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

ENGINEERS' SOCIETY OF WESTERN NEW YORK. Sec.: L. W. Eighmy, 13 City Hall, Buffalo. Regular meetings, first Tuesday of each month, except July and August.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA. Sec.: Chas. W. Ridinger, 410 Penn. Ave., Pittsburg. Regular meetings on third Tuesday of each month.

FRANKLIN INSTITUTE. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. Regular monthly meetings of the various sections on other days.

International Association of Municipal Electricians. Sec.: Frank P. Foster, Corning, N. Y. Meeting, September, Atlantic City, N. J.

Iowa Railway Club. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

League of American Municipalities. Sec.: John MacVicar, Des Moines, Iowa. Seventh annual convention, Oct. 7-9, at Baltimore.

Louisiana Engineering Society. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

Master Car Builders' Association. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 29 to July 1, Saratoga Springs, N. Y.

Modern Science Club. Sec.: R. Henderson, 302 Livingston St., Brooklyn. Meetings every Tuesday.

Montana Society of Engineers. Sec.: Richard R. Vail, Butte, Mont. Regular meetings on second Saturday in each month.

National Electrical Contractors' Association of the United States. Sec.: W. H. Morton, Utica, N. Y. Next meeting, July 15-17, at Detroit.

New England Railroad Club. Sec.: Edw. L. Janes, Back Bay P. O., Boston, Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

New York Electrical Society. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays.

New York Railroad Club. Sec.: F. M. Whyte, Grand Central Station, N. Y. City. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

North-West Railway Club. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

Pacific Coast Railway Club. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at different cities.

Pacific Northwest Society of Engineers. Sec.; G. F. Cotterill, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

Railway Club of Pittsburg. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

Railway Signaling Club. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov. Annual meeting, Nov. 10, at Detroit.

Richmond Railroad Club. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

Roadmasters and Maintenance of Way Association. Sec.: Chas. McEniry, Cedar Rapids, Iowa. Annual meeting, Oct 13, 14 and 15, at Kansas City, Mo.

Rocky Mountain Railway Club. Sec.: J. E. Buell, 906 20th Ave., Denver. Regular meetings on first Saturday after the 15th of each month.

St. Louis Railway Club. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

Society for the Promotion of Engineering Education. Sec.: C. A. Waldo, Purdue University, Lafayette, Ind. Annual convention, July 1-3, at Niagara Falls.

Society of Chemical Industry, New York Section. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, at Chemists' Club, 108 W. 55th St.

Southern and Southwestern Railway Club. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov.

Technical Society of the Pacific Coast. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

Texas Railway Club. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

Traveling Engineers' Association. Sec.: W. O. Thompson, Oswego, N. Y. Next meeting, Sept. 8, Chicago.

Western Railway Club. Sec.: Jos. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

Western Society of Engineers. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—Mr. Willis G. Dodd, who has been connected with the Union Iron Works, of San Francisco, for many years, has recently been elected president of that company.

—Messrs. H. B. Coho & Company, the contracting engineers of 114 Liberty Street, New York, have issued a tasteful pamphlet, with views of some of the plants they have equipped.

—Mr. W. O. Duntley, vice-president and general manager of the Chicago Pneumatic Tool Company, has recently returned from a short business trip abroad in the interests of his company. While on the Continent, Mr. Duntley visited several of the most prominent shipyards, manufacturing establishments, etc., and brought back with him a large number of orders for the various pneumatic appliances manufactured by his company.

—Mr. John A. Caldwell, formerly with the American Stoker Co., has now become the general sales manager of the Wilkinson Manufacturing Co., of Bridgeport, Pa., with offices at 45 Broadway, New York.

—Mr. George Welsby Scott, the consulting engineer, has removed from "The Rookery" to larger offices in the Security Building, Chicago, where increased facilities will enable him to more fittingly care for the interests of those intrusting to him matters within the lines of general engineering.

—Mr. S. Morgan Smith died recently at Los Angeles, Cal., after an illness lasting several months. He was the founder and head of the S. Morgan Smith Co., of York, Pa., the well-known manufacturers of water wheels and power transmitting machinery.

—Mr. A. Rieppel, Koeniglicher Baurat, of Nürnberg, Germany, the managing director of the Augsburg-Nürnberg Manufacturing Co., well known for many years as one of the largest and most successful builders of structural iron work, engines, cars, bridges, etc., in Europe, is now visiting this country for the first time. Mr. Rieppel's visit to this country was made to interest the Allis-Chalmers Company in the manufacture of the products of his company, and by mutual agreement to enable each or either of them to get into closer touch with the requirements of the trade throughout the world. A contract was entered into by the two companies, giving the Allis-Chalmers Company the exclusive right to manufacture and sell the Nürnberg gas engine for this country and selling rights in many foreign countries, especially the far east and South Africa. The Augsburg-Nürnberg Manufacturing Company, under the direction of Mr. Rieppel, have made a phenomenal success with this new gas engine, having within the past few months received orders for some 50,000 H. P. throughout Germany and Spain, chiefly for generating electric energy and for blast-furnace and spinning-mill work.

Industrial Notes.

—The Brown Corliss Engine Co., of Corliss, Wis., are looking for a number of good agencies to handle their work in different parts of the country.

—The New York, Ontario & Western Railway, whose main line extends from New York City to Oswego, N. Y., on Lake Ontario, and which has branches to Kingston, N. Y., Scranton, Pa., Utica, N. Y., and Rome, N. Y., has some desirable factory sites, with water power, along its line that would pay manufacturers to look into. The freight shipping facilities for raw material in, and the finished product out, are of the best. Call on, or address, J. C. Anderson. General Freight Agent, 56 Beaver Street, New York City.

—The American Committee on Standard Specifications for Cast Iron and Finished Castings recently held a meeting in Philadelphia, for organization. Mr. Walter Wood, the chairman, appointed sub-committees on pig iron, pipe, cylinders, car wheels, malleable cast iron, general castings, and testing cast iron. The reports of these sub-committees will be referred to the full committee, and afterwards to the International Congress for Testing Materials. It is desired that progress reports shall be ready to be submitted to the meeting of the full American Committee at the Delaware Water Gap meeting of the American Society for Testing Materials, on July 1, 2 and 3.

The romantic and beautiful situation of the new "Royal Muskoka" hotel, located in the heart of one of the most magnificent summer resort districts in America, the "Highlands of Ontario," bordering on Georgian Bay, inspires anticipations of the most pleasant sort. Every comfort and luxury that modern civilization has given us is found in this great hotel, which can accommodate 350 people. There is direct telegraph service with the hotel, which is about six hours' journey north of Toronto, with excellent transportation service, furnished by the Grand Trunk Railway. Illustrated descriptive literature giving all particulars regarding routes and rates, etc., can be had on application to F. P. Dwyer, Eastern Passenger Agent of the Grand Trunk Railway System, Dun Building, 290 Broadway, New York.

—The M. Garland Co. have installed conveyors, in which over a mile of cable has been used, for the Union Bag & Paper Co., at Sandy Hill, N. Y., for conveying pulp wood. This is claimed to be the largest installation for this purpose in the United States, if not in the world.

—Pratt & Whitney Co., of Hartford, Conn., the well known manufacturers of machine tools, have issued a neat daily memorandum pad, called the "Wisdom Calendar," with extracts from George H. Lorimer's "Letters from a Self-Made Merchant to His Son."

—The constantly increasing demand for Christensen air brakes and "Ceco" electrical machinery has made necessary a change in the organization of the Christensen Engineering Company. To accomplish this result, the owners of the stock of this company have organized the National Electric Company, and the assets, good will, etc., of the Christensen Co. have been transferred to the National Electric Co., the purposes, ownership, management and control of the new company being identical with those of the old.

—The Lunkenheimer Company, Cincinnati, report that on account of the unprecedented demand for their superior line of brass and iron steam specialties, they have been compelled to increase their foundry output 50 per cent. Machine tools of the most improved type are being installed in various departments as fast as they can be obtained.

—The American Blower Co., of Detroit, Mich., has recently opened offices in Philadelphia and Pittsburg. The former is at 615 Hale Building, in charge of Mr. Benj. Adams, ,and the latter at 318 Frick Building, in charge of Mr. H. P. Curtiss.

—The output of Lake Superior graphite is controlled by the Detroit Graphite Manufacturing Company. This company's plant is equipped with its own peculiar machinery for fine grinding and mixing, the result of many years of study and experience. Their graphite paints are in use on all kinds of engineering work throughout the country. Their machinery paints are well known for their efficiency for all grades of work. In fact, this company is prepared to meet any problem in the paint line. Further information can be had by addressing The Detroit Graphite Manufacturing Co., Detroit Mich.

—The Tabor Mfg. Co., of Philadelphia, has arranged with The Draper Co., of Hopedale, Mass., for the manufacture and sale of the hand rammed molding machines, which the latter firm has been building for its own use. The Draper Co. has had probably the longest experience in molding by machinery of any firm in this country, and consequently their machines represent the result of years of experimenting, including the trying of many other machines now on the market. At present they have in operation in their Hopedale plant several hundred of these machines. They are on wheels and are light and cheap, and do not require power to operate them.

—A very clever device for double indexing blank books, has just been placed on the market by Mr. John C. Moore, of 127 Stone Street, Rochester, N. Y. It consists of a small steel "Movable Marker" which is slipped over the outer edge of the leaf, so as to be in a line with a series of figures or letters which are attached to the extreme edge of the book, making it an easy matter to arrange the records both alphabetically and according to date, at the same time in the same book. The manufacturer of this valuable device has recently published a book containing nearly one hundred pages of useful information on the subject of scientific accounting by the loose-leaf method, which he will gladly forward gratuitously, to any one sufficiently interested to ask for it.

—The Standard Paint Company, manufacturers of the well-known Ruberoid roofing and the P & B products, was organized in 1886 with Ralph L. Shainwald as president; Silas S. Packard, since deceased, vice-president, and Felix Jellinik, secretary and treasurer. Mr. Shainwald and Mr. Jellinik have continuously held their offices since. Mr. Max Drey is the present vice-president. The first factory was erected at Bound Brook, N. J., on a part of the site of the present works. The Standard Paint Company were the first to place upon the market an odorless, water-proof insulating paper, and the first to make a liquid insulating compound which could be applied without heat and which therefore supplied a long felt need in the electrical field. They were also the first manufacturers of a ready roofing (Ruberoid) which was odorless, weather-proof and elastic. In view of the very excellent quality of these manufactures it was but natural that the demand should be enormous. This demand has so steadily increased as to grow beyond the capacity of the works, and extensions of the plant and purchases of additional land have been continuously necessary from the beginning. The latest addition to the works is a building from 350 to 375 feet in length, which was recently the scene of a housewarming party, given by the Standard Paint Company to their employees, with whom they have always maintained the most cordial relations.

—The Philadelphia Pneumatic Tool Co. has furnished all the pneumatic tools for the erection of forty-five steel bridges that the Southern Pacific Company are erecting incident to the straightening of their line between Ogden, Utah, and Reno, Nevada. Large orders for chipping hammers, riveters and drills have been received, also, from the Baldwin Locomotive Works, American Car & Foundry Co., Pennsylvania Steel Co., American Bridge Co., Vulcan Iron Works, Toledo, and the Lake Shore & Michigan Southern Ry.

—The Rand Drill Company report the removal of their San Francisco office from 223 First St., to the Rialto Building, additional space being needed because of the rapidly expanding business of this company on the Coast.

—E. P. Roberts & Company, consulting engineers, Electric Building, Cleveland, Ohio, announce that owing to the increasing demands of their eastern business they have opened a branch office at 25 Broad Street, New York City. This office has been placed under the management of William C. Andrews, E. E., eastern representative of the company, and will provide greatly increased facilities for following the interests of their clients.

—The Power Specialty Company, of New York, have received orders from the Wellman-Seaver-Morgan Engineering Co., for a superheater similar to the one they installed for them in Oct., 1901; from the Enterprise Mfg. Co., of Philadelphia, for three superheaters to be exact duplicates of one they installed for them in Oct., 1902; from E. Keeler Co. for a superheater to be installed in the Jersey Shore plant of the Williamsport Passenger Railway Co.; from the Massachusetts Electric Co. for a superheater to be installed in their Quincy power station to superheat the steam for a 3,000-kilowatt Curtis turbine; and from the Carbondale Machine Co. for a superheater to be used in connection with an ice machine they are building.

—Owing to the necessity of obtaining more room, Robert W. Hunt & Co. have moved their New York office to No. 66 Broadway. Messrs. John J. Cone and James C. Hallsted, of the firm, sailed for Europe recently on the Campania, the former returning abroad after a few weeks' visit home. Mr. Hallsted has gone over to give his personal supervision to the inspection of the structural material for two large London hotels, which has been awarded to his firm. These contracts, together with several others for buildings to be erected in England and South Africa, as well as for the bridge material for this continent, has compelled the firm to organize a foreign structural and bridge department, in addition to the one in charge of rails, splice bars, billets, etc., etc.

—The Webster, Camp & Lane Company, of Akron, Ohio, and The Wellman-Seaver-Morgan Engineering Company, of Cleveland, O., have consolidated under the new corporate name of The Wellman-Seaver-Morgan Company. The general offices of the new company will be located at Cleveland, Ohio, to which address all general correspondence and remittances should be sent. Correspondence for the Akron plant should be addressed to the Webster-Camp-Lane Division of The Wellman-Seaver-Morgan Company, Akron, Ohio. The officers of the new company are as follows: President, S. T. Wellman, Cleveland; chairman, John McGregor, Akron; 1st vice-president, S. H. Pitkin, Akron; 2nd vice-president, J. W. Seaver, Cleveland; 3rd vice-president, G. H. Hulett, Cleveland; general manager, C. H. Wellman, Cleveland; secretary, T. R. Morgan, Cleveland; treasurer, A. D. Hatfield, Cleveland. The new company will continue the lines of work of the two old companies, and with the two modern plants working together, they are in position to make prompt deliveries, and guarantee the very best workmanship and material, on any requirements which may be in their line of work. The engineering department is one of the largest and most comprehensive in the world, and they offer their services as consulting and contracting engineers in general practice.

—Allis-Chalmers Company, Chicago, U. S. A., announce that the general offices of the company are now located in the New York Life Building, 14th floor, corner of La Salle and Monroe Streets.

—Messrs. Spon & Chamberlain, the well-known publishers and importers of technical books, have issued a series of sheets containing a set of specifications for the design and testing of continuous-current dynamos, based on Prof. Silvanus P. Thompson's book on the "Design of Dynamos."

—The Eureka Fire Hose Co. is building an extension to its factory in Jersey City, that will afford additional space needed by its twisting and weaving departments. The extension is about 118 by 50 feet, with four floors, and will make the total area of the company's main brick factory about three acres. This main building will be 399 feet in length, averaging 90 feet in width, and four stories in height. The extension, like the present building, will be built and equipped in accordance with most approved factory insurance practice. The machinery to be installed will be electrically driven, and the electric lighting, telephone and fire alarm systems of the present mill will be extended into the new structure. The extension is an evidence of the intention of the Eureka Fire Hose Co. to continue to maintain for its factory the reputation that it has borne for more than a quarter century, as the largest and most perfectly equipped fire hose factory in the world.

—The Loomis-Pettibone Company have removed their New York offices from No 52 Broadway to 52 and 54 William Street. They have recently increased their capitalization to $2,000,000, and are about to begin the construction of a large plant, near New York, for the manufacture of gas engines in large units, in addition to the Loomis-Pettibone gas apparatus, which they will continue to manufacture as heretofore. The name of the new company is the Loomis-Pettibone Gas Machinery Company, and its officers and directors are: Benjamin Guggenheim, president; Cyrus Robinson, 1st vice-president and general manager; Burdett Loomis, Jr., 2nd vice-president and manager sales department; Leon P. Feustman, secretary and treasurer; Burdett Loomis, Sr., consulting engineer; Hawley Pettibone, chief engineer; Charles E. Finney. The company is now prepared to enter into contracts for the equipment of complete plants, gas generators, gas engines, and electric generators and motors. Until their own plant is ready to turn out large gas engines, they will deliver the engines manufactured by Crossley Brothers, Ltd., Manchester, England, for which they have the exclusive agency for North America. The Loomis-Pettibone Co. have installed a number of large gas-engine plants in the United States and Mexico, and call attention particularly to the following installations: Minas Tecolotes y Anexas, Guggenheim Exploration Co., owners, Santa Barbara, Chihuahua, Mexico; capacity, 700 H. P.; Montezuma Copper Co., Phelps, Dodge & Co., owners, Nacosari, Sonora, Mexico; capacity, 1,000 H. P.; Detroit Copper Mining Co., Phelps, Dodge & Co., owners, Morenci, Arizona; capacity, 1,000 H. P.; Winchester Repeating Arms Co., New Haven, Conn.; capacity, 1,000 H. P. They have also recently closed contracts for a number of other power plants in Mexico and the United States. The Loomis-Pettibone Co. are producing power with a consumption of 2½ pounds of wood per brake horse-power hour, or with one pound of good bituminous coal. The economic production of power under all conditions with such installations is therefore apparent. This company call the attention of all users of power to the careful consideration of the above facts, and will be pleased to furnish any information that may be desired.

—During the last four months, the Pacific Department of the Pelton Water Wheel Co. has received contracts for water wheels for the largest and most important hydro-electric plants west of Niagara. In every instance, the wheels must conform with the speed of the generators, to permit of direct connection, and as the heads under which they operate are of both extremes, viz., from 65 feet to 2,100 feet, some idea of the adaptability and vast range of Pelton apparatus in this comparatively new industry, may be imagined.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Air Compressors.

Catalogue A, illustrating and describing the many types of the American air compressors, air receivers, vacuum pumps, carbonic-acid-gas and high-pressure compressors, and the American air-lift pumping system, with information about pneumatic tools and a table showing the flow of air through various sized orifices. 9 by 6 in.; pp. 54. American Air Compressor Works, 26 Cortlandt St., New York.

Air Pumps.

Catalogue, with illustrations and description of the Edwards patent air pump, for marine and stationary engines, with steam or electric drive. 5½ by 8½ in.; pp. 14. Wheeler Condenser & Engineering Co., 120 Liberty St., New York.

Accumulators.

Bulletins, devoted to installations of "Chloride Accumulators" at the Alum Rock station of the San Jose and Santa Clara Railway Co., San Jose, Cal., Edison stations in Brooklyn and New York, and other electric light and power plants. 10½ by 8 in. The Electric Storage Battery Co., Philadelphia.

Blue-Printing Machine.

Circular describing and illustrating an automatic lamp controller for a cylindrical electrical copier, for making blue prints by electric light. 9 by 6 in.; pp. 4. Pittsburg Blue Print Company, Pittsburg.

Boilers.

Circular No. 117, giving a description of a boiler shop, a list of users of boilers, and illustrations of works, shop interior and high grade boilers. 11½ by 9 in.; pp. 4. Lombard Iron Works and Supply Company, Augusta, Georgia.

Core Ovens.

Catalogue, with descriptions and full-page illustrations of Millett's patent core oven for foundry purposes, which has swinging shelves with rear doors for closing the opening to oven when shelves are open. This oven is also made in portable form. Testimonials and long list of users. 9½ by 7½ in.; pp. 32. Millett Core Oven Co., Brightwood, Mass.

Drop Forgings.

Pamphlet containing the story of John Stevens and his sons and their many remarkable inventions and contributions to engineering progress. Also, illustrations of gear blanks, crank shafts and other high grade drop forgings. 7 by 4½ in.; pp. 12. Wyman & Gordon, Worcester, Mass.

Electric Conduit.

Circular, with illustrations and description of fibre conduit for underground electric conductors, both slip joint and screw joint styles, with bends, elbows, couplings, etc. 6 by 3½ in.; pp. 4. Also, card, with useful tables. The Fibre Conduit Co., Orangeburg, N. Y.

Hoists and Derricks.

Large catalogue, 1903 edition, with descriptions and illustrations of hoisting engines, belt-power, electric, horse-power and hand-power hoists, many kinds of derricks, locomotive cranes, elevators, wire rope and fittings, blocks, winches, and other kinds of contractors' and quarrymen's machinery. 12 by 9 in.; pp. 128. American Hoist & Derrick Co., St. Paul, Minn.

Incandescent Lamps.

Booklet devoted to the merits of the "Sterling Special" incandescent electric lamp, the filament of which is so constructed that it furnishes sixteen candle power of light "all ways always." 6 by 3½ in.; pp. 11. Sterling Electrical Manufacturing Co., Warren, Ohio.

Irrigation.

Circular devoted to power irrigation, with illustrations and descriptions of the Colorado gasoline engine for pumping water and for other purposes, and of the Deluge centrifugal pump. The Irrigation and Mining Supply Co., Denver, Colo.

Kerosene Engines.

Catalogue A 30, with illustrations and descriptions of Mietz & Weiss gas and kerosene engines, both stationary and portable, for pumping, hoisting, compressing air, generating electric currents and general power purposes. Also, testimonials of users. 6 by 9¼ in.; pp. 24. August Mietz, 126-138 Mott St., New York.

Launches.

Catalogue with illustrations, plans and descriptions of many styles and sizes of Lozier high-grade launches and yachts equipped with gasoline engines. The Lozier Motor Company, Plattsburg, N. Y.

Locomotor Engines.

Large catalogue, illustrating and describing traction engines, hauling engines, road locomotives, and portable engines, for all kinds of work, on all sorts of ground and roads. Also, wagon cars, single or in train, for transporting stone, ore, lumber and general merchandise. 10 by 8 in.; pp. 40. Buffalo Pitts Company, Buffalo.

Machine Tools.

Large pamphlets, devoted, respectively, to horizontal boring, drilling and milling machines and to multiple drills, with half-tone illustrations and descriptions of the finest and most modern examples of machine tools of these classes. 12 by 9 in.; pp. 48. Niles, Bement, Pond Co., 136-138 Liberty St., New York.

Mechanical Stoker.

Large pamphlet, with illustrations and description of the Wilkinson automatic mechanical stoker, the works where it is manufactured and plants where it is in use, together with many testimonials from users. 12½ by 8 in.; pp. 29. Wilkinson Manufacturing Co., Bridgeport, Pa.

Mond Gas.

Large book, illustrating and describing the Mond producer gas process, with and without the recovery of ammonia, and many applications of this gas for power and other purposes, together with views of plants, diagrams, tables, working figures, etc. 10½ by 8¼ in.; pp. 104. R. D. Wood & Co., Philadelphia.

Narrow-Gauge Railways.

Catalogue No. 77, devoted to portable and industrial railway equipments for hand, steam and electric power, with illustrations and descriptions of rails, track, switches, frogs, turntables, many kinds of cars for a great variety of purposes, and narrow-gauge railway materials of all descriptions, with views of places where these railways are installed. 10 by 8 in.; pp. 80. Arthur Koppel, 66-68 Broad St., New York.

Oil Engine.

Pamphlet, with descriptions and half-tone illustrations of Secor kerosene-oil engines for general power purposes, and particularly as directly connected to electric generators in a self-contained unit, together with a general account of the Secor power system. 9 by 6 in.; pp. 26. The General Power Company, 81-83 Fulton St., New York.

Oiling Devices.

Catalogue, with illustrated descriptions of self-closing, dust-proof, special oil cups for special places, in many styles, and auxiliary oiling devices. 9¼ by 6 in.; pp. 16. Bower Manufacturing Co., Auburn, N. Y.

Pneumatic Hammers.

Pamphlet, with illustrated descriptions of the Haeseler-Ingersoll "axial valve" air hammers for chipping, riveting, scaling, caulking, flue beading and other purposes, and also of other pneumatic tools and apparatus. 9 by 6 in.; pp. 16. Haeseler-Ingersoll Pneumatic Tool Co., 26 Cortlandt St., New York.

Pneumatic Tools.

Circular No. 35, with illustrations and descriptions of pneumatic long-stroke riveting hammers, chipping, caulking and beading hammers, piston air drills, air compressors, pneumatic painting machines, and other kinds of pneumatic machinery. 12 by 9½ in.; pp. 2. Chicago Pneumatic Tool Co., Chicago.

Pumping Machinery.

Special booklet No. 32, with illustrations and descriptions of boiler feed pumps, low service pumps, underwriter fire pumps, artesian engines for operating working barrel in artesian wells, hydraulic pressure pumps, combined gasoline engine and pump, and other kinds of steam and power pumping machinery. 6¼ by 3½ in.; pp. 24. Fairbanks, Morse & Co., Chicago.

Roller Bearings.

Pamphlet, with illustrations and descriptions of Moffett roller bearings for fire apparatus, automobiles, electric motors, electric cars, railway cars, etc. 7 by 9½ in.; pp. 8. Also, a pamphlet containing a report of tests of Moffett roller bearings in comparison with sliding bearings made at the Armour Institute of Technology by Professors C. V. Kerr and A. M. Feldman. 9 by 6 in.; pp. 54. S. B. Thorp, Moffett Roller Bearings, 290 Broadway, New York.

Rolling-Mill Machinery.

Large, cloth-bound book, illustrating and describing steam engines for blast furnaces and power purposes, rolling mills, steam and hydraulic shears, rail-straightening presses, hydraulic presses, steam hammers, and other kinds of blast-furnace, rolling-mill and steel works machinery. 9½ by 12¾ in.; pp. 50. Mackintosh, Hemphill & Co., Pittsburg.

Sawing Machinery.

An "art nouveau" pamphlet, entitled "Instructions on the Erection and Care of Band Sawmills, Band Resaws, Band Saws, etc.." and dedicated to "the sawyers of the world," with illustrations and descriptions of many kinds of wood-sawing machinery. 7 by 5 in.; pp. 24. J. A. Fay & Egan Co., Cincinnati.

Sewer Pipe.

Catalogue, with price lists, descriptions and illustrations of sewer pipe, culvert pipe, water pipe, fire-clay flue linings, fire brick, drain tile, Porter paving brick, and other clay goods, and manhole heads and other castings, together with many items of useful information and discount table. 9 by 6 in.; pp. 62. Arthur N. Pierson & Co., 1 Park Row, New York.

Steam Engines.

A catalogue, with half-tone illustrations and descriptions of the Reeves compound steam engines, of both vertical and horizontal types, with details of the cylinder and valve mechanism, the steam distribution and the adjustable piston valve, together with some information concerning the Reeves automatic single-cylinder engines. 9 by 6 in.; pp. 48. The Reeves Engine Co., 83 Liberty St., New York.

Summer Homes.

Illustrated catalogue, with embossed cover in colors, very beautiful half-tone engravings and full-page plates in tint, and several maps. Issued by the New York, Ontario & Western Railway. Gives concise information concerning every point on or accessible from the main line and branches of the road—its position, elevation, the fare from New York, the fishing and other attractions, and the situation and rates of all hotels and boarding houses. The information is full, accurate, well arranged and well indexed. A handsome and useful publication. 9¼ by 6¼ in.; pp. 166. J. C. Anderson, G. F. A., 56 Beaver St., New York.

Transformers.

Bulletin No. 132, with illustrations and descriptions of S. K. C. large transformers and special transformers and their details. 10½ by 8 in.; pp. 8. Stanley Electric Manufacturing Co., Pittsfield, Mass.

News Supplement

The Engineering Magazine—July, 1903

Coming Society Meetings.

American Boiler Manufacturers' Association. Sec.: J. D. Farasey, Cleveland. Next meeting July, at Chattanooga.

American Institute of Eletrical Engineers. Sec.: Ralph W. Pope, 95 Liberty St., New York. Annual convention, June 29-July 3, Niagara Falls. Regular meeting on fourth Friday of each month, except June, July and August, 12 W. 31st St., New York.

American Institute of Mining Engineers. Sec.: R. W. Raymond, 99 John St., New York. Next meeting, October, at New York.

American Park and Outdoor Art Association. Sec.: C. M. Robinson, Rochester, N. Y. Annual meeting, July 7-9, at Buffalo.

American Railway Association. Sec.: W. F. Allen, 24 Park Place, New York. Next meeting Oct. 28, at Richmond, Va.

American Railway Mechanical and Electrical Association. Sec.: Walter Mower, Detroit. First annual meeting, Sept. 1-4, Saratoga Springs, N. Y.

American Society of Civil Engineers. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August.

American Society of Heating and Ventilating Engineers. Sec.: W. M. Mackay, P. O. Box 1818, New York. Annual convention, July 17 and 18, at Niagara Falls.

American Society for Testing Materials. Sec.: Prof. Edgar Marburg, University of Pennsylvania. Convention July 1, 2 and 3, at Delaware Water Gap.

American Street Railway Association. Sec.: T. C. Penington, 2020 State St., Chicago. Annual meeting, Sept. 2-4, Saratoga Springs, N. Y.

Association of Railway Superintendents of Bridges and Buildings. Sec.: S. F. Paterson, Concord, N. H. Annual convention, Oct. 20, Quebec.

Boston Society of Civil Engineers. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

Canadian Railway Club. Sec.; W. H. Roseveаr, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

Canadian Society of Civil Engineers Sec.: Prof. C. H. McLeod, 877 Dorchester St. Montreal. Regular meetings every alternate Thursday, from October to May, inclusive.

Central Railway Club. Sec.: Harry D. Vought, 62 Liberty St., New York, Regular meetings on second Fridays of Jan., March, May, Sept. and Nov., Hotel Iroquois, Buffalo.

Chicago Electrical Association. Sec.: W. J. Warder, Jr., 900 Warren Ave. Regular meetings on first Friday of each month, from October to May.

Civil Engineers' Club of Cleveland. Sec.: Arthur A. Skeels, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

Civil Engineers' Society of St. Paul. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

Engineering Association of the South. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

Engineers' Club of Chicago. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

Engineers' Club of Cincinnati. Sec.: J. F. Wilson, P. O. Box 333. Regular meetings on third Saturday of each month, except July and August.

Engineers' Club of Columbus (Ohio). Sec.: H. M. Gates, 12½ North High St. Regular meetings on third Saturday of each month, except July and August.

Engineers' Club of Minneapolis. Sec.: Edw. P. Burch, 1210 Guaranty Bldg. Regular meetings on third Mondays.

Engineers' Club of Philadelphia. Sec.: J. O. Clarke, 1122 Girard Street. Regular meetings on first and third Saturdays of each month, except July and Aug.

Engineers' Club of St. Louis. Sec.: H. T. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

Engineers' Society of Western New York. Sec.: L. W. Eighmy, 13 City Hall, Buffalo. Regular meetings, first Tuesday of each month, except July and August.

Engineers' Society of Western Pennsylvania. Sec.: Chas. W. Ridinger, 410 Penn. Ave., Pittsburg. Regular meetings on third Tuesday of each month.

Franklin Institute. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. Regular monthly meetings of the various sections on other days.

International Association of Municipal Electricians. Sec.: Frank P. Foster, Corning, N. Y. Meeting, September 2-4, Atlantic City, N. J.

Iowa Railway Club. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

League of American Municipalities. Sec.: John MacVicar, Des Moines, Iowa. Seventh annual convention, Oct. 7-9, at Baltimore.

Louisiana Engineering Society. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

Master Car Builders' Association. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meeting, June 29 to July 1, Saratoga Springs, N. Y.

Modern Science Club. Sec.: R. Henderson, 302 Livingston St., Brooklyn. Meetings every Tuesday.

Montana Society of Engineers. Sec.: Richard R. Vail, Butte, Mont. Regular meetings on second Saturday in each month.

National Electrical Contractors' Association of the United States. Sec.: W. H. Morton, Utica, N. Y. Next meeting, July 14-17, at Detroit.

New England Railroad Club. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

New York Electrical Society. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays.

New York Railroad Club. Sec.: F. M. Whyte, Grand Central Station, N. Y. City. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

North-West Railway Club. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

Pacific Coast Railway Club. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at different cities.

Pacific Northwest Society of Engineers. Sec.: G. F. Cotterill, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

Railway Club of Pittsburg. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

Railway Signaling Club. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov. Annual meeting, Nov. 10, at Detroit.

Richmond Railroad Club. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

Roadmasters and Maintenance of Way Association. Sec.: Chas. McEniry, Cedar Rapids, Iowa. Annual meeting, Oct. 13, 14 and 15, at Kansas City, Mo.

Rocky Mountain Railway Club. Sec.: J. E. Buell, 906 20th Ave., Denver. Regular meetings on first Saturday after the 15th of each month.

St. Louis Railway Club. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

Society for the Promotion of Engineering Education. Sec.: C. A. Waldo, Purdue University, Lafayette, Ind. Annual convention, July 1-3, at Niagara Falls.

Society of Chemical Industry, New York Section. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, at Chemists' Club, 108 W. 55th St.

Southern and Southwestern Railway Club. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov.

Technical Society of the Pacific Coast. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

Texas Railway Club. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

Traveling Engineers' Association. Sec.: W. O. Thompson, Oswego, N. Y. Next meeting, Sept. 8, Chicago.

Western Railway Club. Sec.: Jos. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

Western Society of Engineers. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—Mr. Charles F. Scott, president of the American Institute of Electrical Engineers, delivered an address to the graduating class at the commencement exercises of Stevens Institute of Technology.

—Mr. R. Van Dorn, formerly with the Struthers-Wells Co., is now general sales manager of the Titusville Iron Co., founders, machinists and boiler makers, of Titusville, Pa.

—Mr. William Burlingham has accepted an appointment as chief engine designer with the B. F. Sturtevant Co., of Hyde Park, Mass., resigning a position in the United States Inspection Office with the Wm. R. Trigg Co., of Richmond, Virginia.

Mr. Burlingham has previously been associated with the Bath Iron Works, the General Electric Co., the Southwark Machine & Foundry Co., and the Newport News Ship-Building & Dry Dock Co. He has also served on Edison's staff at the Orange Laboratory, and is a graduate of the Worcester Polytechnic Institute.

—Mr. H. E. Maxfield, formerly resident agent for Lawrence Centrifugal Pumps, 39-41 Cortlandt Street, will hereafter be known under the firm name of H. E. Maxfield & Co., with offices at No. 136 Liberty Street, New York, where all inquiries received for centrifugal pumping machinery, house pumps, hoisting engines and general machinery, will be given prompt attention.

—Mr. Henry R. Cornelius, of Pittsburg, for so many years direct representative of the Southwark Foundry & Machine Co., of Philadelphia, has taken entire charge of the output of the Brown Corliss Engine Co., in the Pittsburg district. He has opened up new offices in the Frick Building, and being so well posted in this territory, should be a very valuable acquisition to the already progressive Brown Corliss Engine Co. Mr. Cornelius has spent a great deal of time in the mills and works at Pittsburg, and is considered one of the best authorities on rolling-mill and blowing engines.

—Mr. E. O. Edson has been elected secretary and treasurer of the Bendit Mercantile Engineering Co., of St. Louis, successors to Laufketter-Bendit Mercantile Enginering Co.

Industrial Notes.

A VERY entertaining little booklet, entitled "New York to Newfoundland—Thirteen Days on the Steamer," by Miss Marion Varian, associate editor of *Compressed Air,* has been issued in attractive form, with a cover in colors, decorated with the American and British flags crossed. The booklet is written in a fresh, breezy style and gives a bright picture of a pleasant trip which took the voyagers down Long Island Sound, past Nantucket, out to sea and across to Nova Scotia and Newfoundland, and included stops at Halifax, St. John, and Sydney. The course after leaving Halifax, on the return trip, was the same as on the outward voyage. There are illustrations of the ship and of the various places visited, made from photographs taken by the author, and the booklet, while being an excellent advertisement for the steamship company, makes a delightful little story on its own account. The author intends to take similar trips during her summer vacations, either by water or on land, and will write them up in the same attractive style, which cannot fail to be of material benefit to the steamship lines and railroads which are favored with her patronage.

—Among the recent sales of the Reeves Engine Co., are two large cross-compound vertical direct-connected engines for the new city lighting plant at Bluffton, Indiana, as well as several direct-connected engines for the Bullock Electric Manufacturing Company, some of which are for export. The works of the Reeves Engine Co. are running night and day with two shifts of men, in their efforts to catch up with the orders they are receiving.

—One of the biggest summer resorts within easy reach of civilization, is what is commonly termed Muskoka, a district in the "Highlands of Ontario" about 100 miles north of Toronto, including an immense tract of country bordering on the Georgian Bay. This district is composed of lakes and rivers innumerable and is situated 1,000 feet above sea level. Good fishing and hunting are assured. Ample hotel accommodation at all points on the lakes is provided to suit the purses of everyone. There is excellent transportation service furnished by the Grand Trunk Railway. Copies of handsome, descriptive literature relating to this country can be had free by applying to F. P. Dwyer, Eastern Passenger Agent of the Grand Trunk Railway System, 290 Broadway, New York.

—The Allis-Chalmers Co. have recently made some large engine sales to a number of customers, including the St. Louis Exposition, the National Tube Co., the Kansas City Water Works and others.

—Westinghouse, Church, Kerr & Co., have recently sold additional train-lighting equipments to the Chicago, Milwaukee & St. Paul, and the Northern Pacific Railway Co., for service on their Special Limited trains. The outfit consists of a 25 or 30-horse-power Westinghouse standard vertical single-acting engine, direct connected to a direct-current generator of corresponding capacity. The units are extraordinarily compact and are located in the front part of the baggage car, which location is favorable for supplying high-pressure steam directly from the locomotive boiler through flexible piping. The direct-connected steam-driven unit possesses many advantages for train-lighting service, and the majority of troubles, incident to the use of other types of apparatus for this service, are avoided. The system is now in use on a large number of roads in this country, including the Chicago & Northwestern, Union Pacific, Lake Shore & Michigan Southern, and Duluth South Shore & Atlantic.

—The Shepherd Engineering Company, manufacturers of the Shepherd steam engines, will, after July 1st, have their general offices and works at Franklin, Pa., where they have secured for the manufacture ot their product the large and modern plant constructed a few years ago by the Grant Tool Company. This plant will enable the Shepherd Engineering Company to take care of its greatly increased business, and will also enable them to make prompt deliveries on future work.

—The legislature of Michigan has passed a bill appropriating $171,900 for the Michigan College of Mines, at Houghton, for the biennium beginning July 1st. The most important item of this appropriation is that of $45,000 for the construction of a metallurgical laboratory. The college intends to erect a substantial building for this purpose, and to thoroughly equip it for experimental work and instruction in the different classes of metallurgical processes. Cyaniding and other wet methods of concentration will be exemplified in the equipment and electro-metallurgy will receive special attention. It is intended to install furnaces of larger capacity than is usual in college laboratories. The board of control of the college is taking steps to create a separate department of ore dressing and metallurgy. The equipment for this department will be housed in the new metallurgical building and in the ore dressing mill now possessed by the college. A man to fill the new chair has not been selected. Beside the amount for a metallurgical laboratory, the bill referred to carries an appropriation of $9,000 for extending the equipment of the department of mining engineering, which now occupies its new building erected last year; $4,000 for completing the equipment of the chemistry building, also erected last year; $2,000 for providing additional cases for the mineralogical museum; and $1,000 for increasing the equipment of the department of mechanical engineering.

—In a plant recently installed in the South by the Pneumatic Engineering Company, 128 Broadway, New York, the air lift system pumps nine million gallons of water per day from four 10-inch wells.

—The Buffalo Steam Pump Company, whose works are at North Tonawanda, has been purchased by Messrs. William F. and Henry W. Wendt, who are also owners of the Buffalo Forge Company and the Geo. L. Squier Manufacturing Company. The North Tonawanda Works of the Steam Pump Co. are to be retained as heretofore, and the main offices will be in Buffalo.

—The steamship "Roseley," which left New York recently for various South African ports, took out what will probably be the first electric locomotive to enter the "Dark Continent." The locomotive, which was manufactured by the C. W. Hunt Company, of West New Brighton, Staten Island, N. Y., is shipped to the order of the DeBeers Consolidated Mines, Ltd., the most powerful mining syndicate in South Africa, for use on one of their plants. The locomotive is of the latest storage-battery type, standard throughout, with the exception of the gauge of the wheels, which is special, to suit the track now in use at the mines.

—The Hancock Inspirator Co., of New York, have received a letter from Mr. W. W. Henry, of Homochitto, Miss., in which he says: "We are using for feeding a boiler one of your inspirators that has been in use about 18 years, and it never gives us a minute's trouble. We work it under all steam pressures from 25 to 140 pounds. I do not believe this can be beaten."

—The Lagonda Manufacturing Co., of Springfield, Ohio, report that the month of May was the best they have ever had since they commenced the manufacture of their tube cleaners. The demand for these machines seems to be growing right along. The Lagonda Co. have been crowded out of the factory which they have been occupying for the past year and have just built a factory of their own which is greatly enlarged, and have equipped it throughout with special tools and machinery adapted for the particular work which they have to do, but even in their new quarters, they are compelled to run overtime in order to keep up with the demand made upon them for machines. This encouraging state of affairs is due largely to the fact that Mr. Weinland is a practical engineer and understands exactly what is needed in the way of a cleaner for removing scale. His knowledge and experience has enabled him to produce a boiler-tube cleaner which is not only a rapid worker, but is strong and durable.

—The Titusville Iron Company have recently completed what is probably one of the largest boiler shops in the country, it being one room 200 feet in width and 425 feet in length, consisting of four 50-foot bays, each of which is equipped with an electric crane of suitable capacity running the full length of the building. Across one end of the building extends the railroad track, upon which railroad cars are run into the works and loaded or unloaded under either of the cranes as desired. A large number of new tools have been recently purchased in addition to the efficient equipment already operated by the company, which have enjoyed a very desirable trade in horizontal tubular boilers and all classes of sheet-iron and heavy-plate work, and with the present enlarged works and equipment expect at least to triple their former output.

—The Peabody Coal Co., of Chicago, have issued a second edition of their large wall map, showing the location of the coal mines in the States of Illinois and Indiana, together with a book of statistics on this subject, including the shipping mines and coal railroads of these states, names of operators, railway connections, coal washing plants, etc., all of which makes a very useful and convenient work of reference.

—The R. B. Carter Co., of 26 Cortlandt St., New York, who are sales agents for G. M. Davis & Son, of Palatka, Florida, manufacturers of cypress wood tanks, tubs, vats, covers and gauges, have issued a handy little case filled with pins, entitled "A Few Pointers on Cypress Tanks."

—The American Diamond Rock Drill Company have recently sold several diamond drills to the Argentine Government. The Government of the Argentine Republic having decided to develop and prospect their mineral lands by means of the diamond drill, sent out an engineer to act in their interest, and to examine all existing machines and methods of boring. After a tour through France, Germany, England and the United States, which included a thorough and complete examination of all machines manufactured, the order was given to the American Diamond Rock Drill Company, who have now supplied the machines.

—The American Blower Co., of Detroit, report business excellent in all of their lines. Among the larger orders recently received they mention heating and induced-draft apparatus for the Ironton (O.) Engine Co.; drying outfits for the Illinois Sugar Refining Co., to be installed at Pekin, Ill.; and the Michigan Starch Co., to be used in their Travers City plant; dry kilns for the Mengel Box Co., of Louisville, Ky.; Brooklyn Cooperage Co., of New York; Buckstege Furniture Co., Evansville, Ind.; Evansville, (Ind.) Desk Co.; Cadillac Cabinet Co., Detroit, and many others.

—The Philadelphia Pneumatic Tool Co., in order to take care of their largely increased business in the middle west, have employed Mr. J. F. Ahern, formerly with the Scully Steel & Iron Co., to assist Mr. A. G. Hollingshead, western sales manager for the Philadelphia Company. This company has also appointed Mr. H. B. Griner, late assistant manager of the Chicago Pneumatic Tool Co., to a position in the main office of the Philadelphia Pneumatic Tool Co. This company reports large orders for chipping hammers, riveters and drills from the Craig Shipbuilding Co., Toledo; Willamette Iron and Steel Co., Portland, Oregon; Kewanee Boiler Works, United Gas Improvement Co.; J. D. Connell Iron Works, New Orleans; Chandler & Taylor Co.; Allis-Chalmers Co.; and others.

—Tests made by Mr. C. W. Weiss at the Mietz & Weiss engine works, 128-138 Mott street, New York City, with Cuban and Brazilian cheap alcohol as fuel in their standard kerosene engine, have been reported as entirely satisfactory. The object was to substitute alcohol for kerosene; the former being considerably cheaper and more readily obtainable in Cuba and South America, whither many of these engines are being exported. It was found that a mixture of four pints of alcohol and two pints of water developed 4 horse power for one hour. The mixture of alcohol and water varies, however, with the quality of the former, being limited by the practical degree of compression prior to combustion. The specific gravity of the mixture is .9; the pure alcohol was .794. The development of the alcohol engine is of the greatest importance to the power question of Cuba, Brazil and the Philippine Islands.

—The Nernst Lamp Company, of Pittsburg, has established a Maintenance Bureau for the purpose of supplying users of Nernst lamps with new burners or holders, so it will not be necessary for the customer to visit or call upon the electric light stations when one of his lamps gives out. The Maintenance Bureau makes a contract to supply to its customers a certain number of extra holders which are kept in a box especially made for this purpose. The customer simply takes one of these extra holders and replaces the old one with it, returning the old holder to the box, which is called for by a messenger attached to the Maintenance Bureau. This messenger takes the burned-out holders to the Bureau and they are refilled and returned to the customer. The taking out and putting in of these holders is as easily accomplished as the changing of incandescent lamps. By this method, the users of Nernst lamps are not put to the inconvenience of notifying the electric light company when the lamp gives out; thus avoiding the necessary delay in having their lamps renewed.

—The American Stoker Company has changed the location of its general offices from New York City to Erie, Pennsylvania, where its stokers are manufactured. This will bring the operating department in closest contact with the manufacturing, and secure even better results in the handling of business. Mr. J. S. Van Cleve, president of the Erie Foundry Company, also becomes general manager of this company, and Mr. Herbert D. Lloyd, vice-president and treasurer. All correspondence should be addressed to the company at Erie, Pa.

—The Harrison Safety Boiler Works announce a change in their sales department, whereby Mr. J. M. Dashiell, who has represented them in New England under the title of the Dashiell Engineering Company, 1103 Paddock Building, Boston, is now placed in charge of their Baltimore section. Their New England office will be continued at the above address under the title of the Harrison Safety Boiler Works, with Mr. John Hickey as their representative.

—The Cost-System and Auditing Company, of New York, makes a specialty of designing and installing factory cost-systems, and so connecting them with the general accounts of a business that a monthly profit and loss account and balance sheet may be easily prepared without taking an inventory by count. Many of the features of the system installed by it are unique, and under it most accurate results are obtained and guess work is entirely eliminated. The fact that this company is conducted by certified public accountants of the State of New York, insures reliability and efficiency, and its president, H. F. Searle, C. P. A., and treasurer, H. C. Maass, C. P. A., have become well known throughout the country as experts in this line of work. Its offices are at 45 Broadway, New York.

—The Alberger Condenser Co., 95 Liberty Street, New York, has acquired control of the Newburgh Ice Machine & Engine Co., Newburgh, N. Y. This engine company has been long and favorably known as a builder of Corliss engines, ice machines and similar high class machinery. It is understood to be the intention of the Alberger Condenser Co. to devote this works principally to the manufacture of improved condensers, vacuum pumps and Corliss pumping machinery, which it is using extensively in connection with high-vacuum condenser installments. The recent developments in this class of work all tend toward the improvement of the parts that make up the condensing equipment. This has been largely brought about by the demand for an extremely high vacuum in connection with steam turbines and the inability of the old types of apparatus to accomplish the results required in an efficient manner. The Alberger Condenser Co. still retains close connection with the Quintard Iron Works, of New York City, but rapidly increasing business has made it necessary to obtain additional facilities for the manufacture of special lines of work.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Chemicals.

Circulars Nos. 168 and 169, with descriptions and price lists of many kinds of chemicals for a great variety of purposes. 12 by 9 in.; pp. 4. The Roessler and Hasslacher Chemical Co., 100 William St., New York.

Coal Handling Machinery.

Catalogue, with illustrations and descriptions of hoisting engines, steam shovels or automatic buckets, revolving screens, cars, sheaves, chains, rails, and other appliances, and of many complete coal-handling plants in active operation. 9¼ by 6¼ in.; pp. 72. George Haiss Mfg. Co., 141st St. and Rider Ave., New York.

Condensers.

Book, with descriptions and illustrations of Wheeler condensers, feed-water heaters, evaporators, centrifugal pumps, and vacuum pans and multiple effects for sugar making, the Volz combined condenser and feed-water heater, the Barnard-Wheeler water cooling towers, and other kinds of condensing and steam engineering apparatus. 6 by 9¼ in.; pp. 120. Wheeler Condenser and Engineering Co., 120 Liberty St., New York.

Cotton Machinery.

Catalogue, in handsomely-designed covers, with well illustrated descriptions of modern high-grade cotton machinery for elevating, cleaning, ginning and pressing cotton, and for blowing and sacking cotton seed. 8 by 10 in.; pp. 58. Thomas-Fordyce Mfg. Co., Little Rock, Ark.

Disc Grinder.

A booklet, with illustration and description of disc grinders having steel discs covered with emery paper, for grinding flat surfaces, and examples of the kind of work a disc grinder will do, and the short time it takes to do it. 6 by 3½ in.; pp. 8. Bayldon Machine and Tool Co., Jersey City, N. J.

Dynamos.

Bulletin No. 30, with illustrations and descriptions of direct-current generators of various types, including some very compact twin generators for connection to steam turbines, their parts and accessories. 10 by 7 in.; pp. 32. Northern Electrical Mfg. Co., Madison, Wis.

Electric Driving.

Brochure, with half-tone illustrations and descriptive text, showing some typical examples of the latest engineering practice in the application of electric motors to machine tools and various other kinds of mechanical devices, and demonstrating the great convenience and flexibility of individual motor driving. 9½ by 6¾ in.; pp. 22. Holtzer-Cabot Electric Co., Boston (Brookline), Mass.

Electric Fans.

Catalogue No. 306, with illustrations, descriptions and prices of Lundell electric fans and their parts, of the desk, ceiling, exhaust and various other types. Also, telegraph code. 9¼ by 7 in.; pp. 20. Sprague Electric Co., New York.

Electric Mining.

"Industrial Series" pamphlet No. 13,000, devoted to "Electricity in Mining," and giving illustrated descriptions of the application of electricity to haulage, hoisting, pumping and air compressing, ventilation, drilling and coal cutting, lighting, gold dredging and other mining operations. 9 by 6 in.; pp. 31. Westinghouse Electric and Manufacturing Co., Pittsburg.

Engine Stop.

A unique pamphlet, with illustrations and descriptions of the Monarch engine-stop and speed-limit systems and the Monarch motor stop, and their operation when stopping machinery in case of accident; with many testimonials. 9½ by 3 in.; pp. 16. The Consolidated Engine-Stop Co., 100 Broadway, New York.

Foundry Supplies.

Complete catalogue and price list No. 36, fully illustrated, of foundry facings and blackings, plumbago, silver and black lead, molders' tools and all other kinds of supplies for iron, brass and steel foundries, pattern makers, machinists, rolling mills, furnaces and steel works 7¼ by 5¼ in.; pp. 320. The J. D. Smith Foundry Supply Co., Cleveland.

Hydraulic Machinery.

Catalogue No. 65, an illustrated index of hydraulic jacks, punches, shears, presses, pumps, riveters, valves and other kinds of hydraulic tools and machinery, full and complete descriptions of which, on separate sheets, will be furnished on request. 9 by 6 in.; pp. 83. The Watson-Stillman Co., 204-210 East 43rd St., New York.

Locomotives.

Record of Recent Construction No. 42, containing "A Study of the Steam Distribution of the Vauclain Compound Locomotive," by Lawford H. Fry, with illustrations in the text and a sheet of diagrams. 6 by 9 in. pp. 16. Baldwin Locomotive Works, Philadelphia.

Machine Tools.

Machinery "blue book" for 1903, cloth-bound, with concise, but complete, descriptions and half-tone illustrations of lathes, planers, drills, milling machines, gear cutters, shapers, grinders, and many other kinds of high-grade modern machine tools. 9¼ by 6¼ in.; pp. 118. Hill, Clarke & Co., Boston.

Milling Machines.

Pamphlet on "Examples of Rapid Milling," with illustrations and descriptions of a variety of interesting milling operations taken from actual practice and showing the class of work for which Cincinnati geared-feed millers are adapted, and the high rate at which they are operated. 9 by 6 in.; pp. 32. The Cincinnati Milling Machine Co., Cincinnati.

Ore Mills.

Pamphlet, with illustrations and descriptions of the Merralls "tension" quartz mill, built on the Chili principle, the Merralls rapid-crushing stamp mill, and other machinery for crushing and working gold and other ores in a rapid and economical manner. 10 by 6 in.; pp. 10. Merralls Mill Co., San Francisco.

Paints.

Catalogue, with artistic illustrations and descriptions of preservative paints for a variety of purposes, building papers, ready roofing, Malthoid roofing, electrical compound, armature varnish, insulating tape, asphalt saturated felt, asphalt for roofing and waterproofing purposes, and other of the well-known P. & B. products. 7 by 5 in.; pp. 24. Also, booklets devoted to these goods. The Paraffine Paint Co., San Francisco.

Pneumatic Tools.

Special circulars, Nos. 38 and 39, illustrating and describing pneumatic riveters, drills and various other types of pneumatic appliances, with views showing the tools at work. Circular No. 38 illustrates special applications of the jam riveter and the Boyer drill. 12¼ by 9½ in.; pp. 4. Chicago Pneumatic Tool Co., Chicago.

Folder, devoted to Keller pneumatic tools for riveting, chipping, ramming, drilling and other purposes. 10 by 4 in.; pp. 4. Philadelphia Pneumatic Tool Co., Philadelphia.

Rail Joint.

Catalogue No. 100, entitled "Kinks," with an illustrated description of the Q & C-Bonzano rail joint, and giving an account of its many excellent points and the reasons therefor. Also, a list of the railroads on which it is used. 9 by 6 in.; pp. 16. The Railway Appliances Company, Chicago.

Speed Change.

Circular, with illustrated description and price list of the "transformed cone pulley" speed change for driving all kinds of machinery. Also catalogue with illustrations, descriptions and price list of friction clutch pulleys, cut-off couplings and other power-transmission apparatus, and sheet with diagrams and tables of friction clutches and shafting. The Moore & White Co., Philadelphia.

Steam Engines.

Catalogue, with illustrations and descriptions of the "20th Century" heavy duty Corliss engine and other kinds of high grade steam engines and their parts and accessories, and Corliss air and gas compressors. 6 by 9 in.; pp. 24. The Lane & Bodley Co., Cincinnati.

Steam Turbines.

Bulletin No. 8, containing an illustrated paper by Privy Councilor Wichert, read before the German Engineers' Convention, on train lighting with De Laval steam turbines operating dynamos on German railways, and also views of De Laval train-lighting sets on American roads. 9 by 6 in.; pp. 32. De Laval Steam Turbine Co., 74 Cortlandt St., New York.

Tools.

Catalogue No. 17, with descriptions and illustrations of rules, tapes, squares, micrometers, gauges, clamps, test indicators, speed indicators, calipers, dividers, patent nail holder and set, screw drivers, levels and other kinds of fine mechanical tools, together with useful tables and data. 7½ by 5 in.; pp. 176. The L. S. Starrett Company, Athol, Mass.

Booklet, with illustrated descriptions of four-spindle turret drill, handy vises, universal joints, countershafts and other tools and machinery for the shop. 3½ by 5½ in.; pp. 12. Vanderbeck Tool Works, Hartford, Conn.

Turbines.

Circular, illustrating special design horizontal turbine water wheels used in the 50,000-horse-power plant of the Michigan Lake Superior Power Co. at Sault Ste. Marie, with results of tests. 9 by 6 in.; pp. 4. The Webster, Camp & Lane Co., Akron. O.

Universal Joint.

Folder, with illustrations and description of Bocorselski's patent universal joint, especially adapted for a flexible connection with the least possible friction. 9 by 6 in.; pp. 4. Bausch Machine Tool Co., Springfield, Mass.

Ventilators.

A pamphlet, with illustrations and descriptions of the Pullman automatic ventilator and its application to office buildings, schools, churches, hospitals, railway and street cars, residences and miscellaneous buildings. This ventilator is placed in the lower sash rail, or just underneath it, and provides an ample supply of pure air with proper diffusion and without drafts. 8 by 5 in.; pp. 32. Pullman Automatic Ventilator Co., 213 Produce Exchange, New York.

Wire Rope.

Catalogue No. 24, with illustrations, descriptions and prices of patent flattened-strand and other kinds of wire rope, hooks, blocks, sheaves, and other fittings and apparatus for wire-rope and cableway work; and also illustrated description of the Leschen Co.'s patent automatic aerial wire-rope tramway. 6 by 3½ in.; pp. 80. A. Leschen & Sons Rope Co., St. Louis.

Wire-Rope Haulage.

Large pamphlet, with handsome half-tone illustrations and diagrams, containing an account of underground wire-rope haulage, as successfully applied in the workings of the Coal Valley Mining Company at Sherrard and Cable, Illinois. 12½ by 9½ in.; pp. 24. The Broderick & Bascom Rope Co., St. Louis.

News Supplement

The Engineering Magazine—August, 1903

Coming Society Meetings.

American Institute of Electrical Engineers. Sec.: Ralph W. Pope, 95 Liberty St., New York. Regular meeting on fourth Friday of each month, except June, July and August, 12 W. 31st St., New York.

American Institute of Mining Engineers. Sec.: R. W. Raymond, 99 John St., New York. Next meeting, October, at New York.

American Railway Association. Sec.: W. F. Allen, 24 Park Place, New York. Next meeting Oct. 28, at Richmond, Va.

American Railway Mechanical and Electrical Association. Sec.: Walter Mower, Detroit. First annual meeting, Sept. 1-4, Saratoga Springs, N. Y.

American Society of Civil Engineers. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August.

American Street Railway Association. Sec.: T. C. Penington, 2020 State St., Chicago. Annual meeting, Sept. 2-4, Saratoga Springs, N. Y.

Association of Railway Superintendents of Bridges and Buildings. Sec.: S. F. Paterson, Concord, N. H. Annual convention, Oct. 20, Quebec.

Boston Society of Civil Engineers. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

Canadian Railway Club. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

Canadian Society of Civil Engineers. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. Regular meetings every alternate Thursday from October to May, inclusive.

Central Railway Club. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Fridays of Jan., March, May, Sept. and Nov., Hotel Iroquois, Buffalo.

Chicago Electrical Association. Sec.: W. J. Warder, Jr., 900 Warren Ave. Regular meetings on first Friday of each month, from October to May.

Civil Engineers' Club of Cleveland. Sec.: Arthur A. Skeels, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

Civil Engineers' Society of St. Paul. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

Engineering Association of the South. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

Engineers' Club of Chicago. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

Engineers' Club of Cincinnati. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Saturday of each month, except July and August.

Engineers' Club of Columbus (Ohio). Sec.: H. M. Gates, 12½ North High St. Regular meetings on third Saturday of each month, except July and August.

Engineers' Club of Minneapolis. Sec.: Edw. P. Burch, 1210 Guaranty Bldg. Regular meetings on third Monday of each month.

Engineers' Club of Philadelphia. Sec.: J. O. Clarke, 1122 Girard Street. Regular meetings on first and third Saturdays of each month, except July and Aug.

Engineers' Club of St. Louis. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

Engineers' Society of Western New York. Sec.: L. W. Eighmy, 13 City Hall, Buffalo. Regular meetings, first Tuesday of each month, except July and August.

Engineers' Society of Western Pennsylvania. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

Franklin Institute. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. Regular monthly meetings of the various sections on other days.

International Association of Municipal Electricians. Sec.: Frank P. Foster, Corning, N. Y. Meeting, September 2-4, Atlantic City, N. J.

Iowa Railway Club. Sec.; P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

League of American Municipalities. Sec.: John MacVicar, Des Moines, Iowa. Seventh annual convention, Oct. 7-9, at Baltimore.

Louisiana Engineering Society. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

Modern Science Club. Sec.: R. Henderson, 302 Livingston St., Brooklyn. Meetings every Tuesday.

Montana Society of Engineers. Sec.: Richard R. Vail, Butte, Mont. Regular meetings on second Saturday in each month.

New England Railroad Club. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

New York Electrical Society. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays.

New York Railroad Club. Sec.: F. M. Whyte, Grand Central Station, N. Y. City. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

North-West Railway Club. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

Pacific Coast Railway Club. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at different cities.

Pacific Northwest Society of Engineers. Sec.: G. F. Cotterill, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

Railway Club of Pittsburg. Sec.: J. D. Conway, P. & L. E. R. R, Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

Railway Signaling Club. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov. Annual meeting, Nov. 10, at Detroit.

Richmond Railroad Club. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

Roadmasters and Maintenance of Way Association. Sec.: Chas. McEniry, Cedar Rapids, Iowa. Annual meeting, Oct. 13, 14 and 15, at Kansas City, Mo.

Rocky Mountain Railway Club. Sec.: J. E. Buell, 906 20th Ave., Denver. Regular meetings on first Saturday after the 15th of each month.

St. Louis Railway Club. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

Society of Chemical Industry, New York Section. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, at Chemists' Club, 108 W. 55th St.

Southern and Southwestern Railway Club. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov., at Atlanta.

Technical Society of the Pacific Coast. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

Texas Railway Club. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

Traveling Engineers' Association. Sec. W. O. Thompson, Oswego, N. Y. Next meeting, Sept. 8, Chicago.

Western Railway Club. Sec.: Jos. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

Western Society of Engineers. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—William Currie, of the Stanley Electric Mfg. Company, who for some time past has been at the Pittsfield Works as Mr. C. C. Chesney's assistant, has been appointed sales engineer of the Chicago office of the company.

—Mr. Stephen W. Baldwin retired from the management of the New York office of the Pennsylvania Steel Company on July 1st, after a service of 25 years. He retains his connection with the company in an advisory capacity and as consulting engineer, with headquarters at 71 Broadway, as heretofore. Mr. A. E. Aeby, his first assistant for the past 14 years, has been appointed to take charge of the New York office.

—Mr. Thomas Chalmers, father of W. J. Chalmers, Chairman of the Executive Committee of the Allis-Chalmers Company, died on July 13th. Thomas Chalmers was the founder of the firm of Fraser & Chalmers, which has been long recognized as one of the world's foremost producers of mining machinery, and which is now merged in the Allis-Chalmers Company.

Industrial Notes.

—At a point 145 miles north of Toronto on the Grand Trunk Railway system is reached one of the most magnificent districts in the Highlands of Ontario, known as the Lake of Bays District. The region comprises a series of connected lakes, over which large steamers are navigated. What greatly adds to the Lake of Bays value as a health-giving and sportsmen's resort is the unmatched purity of the air one breathes upon its heights. The visitor forgets his ills under its reviving influence in less than a week, and sees life's problems in a smoother light, enjoying the good things which Nature has prepared for him. Its bracing morning breeze, which rivals the celebrated atmosphere of Pike's Peak, Col., imparts new lung power and fresh vitality. Handsomely illustrated publications describing this region and the best way to reach it will be sent free on application to F. P. Dwyer, Eastern Passenger Agent of the Grand Trunk Railway System, 290 Broadway, New York.

—The Tracy Engineering Co., of San Francisco, Cal., have recently been awarded the contract for supplying 5,000 horse power of Edgemoor water-tube boilers, and have also received an order for a Nordberg-Corliss compound engine of 2,500 horse power, for direct connection to a Wagner-Bullock alternating-current generator. Both of these orders were from the Pacific Electric Railway Co., of Los Angeles.

—The International Sewage Disposal Co., 1009 Paddock Building, Boston, has received the contract for a sewage disposal plant at the Middlesex School, Concord, Mass., where the system in use had been discarded. This company now has several plants in successful operation, among them being Mr. Thomas W. Lawson's extensive stock farm at Egypt, Mass., where sewage at the rate of fifteen thousand gallons per day is successfully treated.

—The National Engineering Co. have opened offices at 214-216 Terrace, Buffalo, N. Y., and as engineers, agents, and contractors will take up a number of branches, among which are the following: As engineers, the mechanical design of machinery, power plants, transmission systems, shops, mills, etc. As agents, they will take charge of installation work for other companies. They will also furnish bids for the making and machining of all kinds of rough castings. As contractors, they will build and install power plants.

—The Navy League of the United States has been organized to awaken public interest in the sea power of the Nation, as the chief instrument by which our country can maintain its rightful position among the world powers, and to promote, in every proper way, the efficiency of the Navy and its growth to a size commensurate with our interests upon the water and over seas. The League is strictly non-partisan in politics. It represents no class or special interest, but every man, woman and child in the United States, except members of Congress and officers and enlisted men of the Navy, is eligible to membership. The Navy League is a national organization, but is made up and maintained by sections organized and to be organized in various parts of the country. Each section has its own local organization and governing committee, controlled by its own members, and it is also represented in the national body by councillors, one of the latter being elected for each one hundred members of the local organization. Individuals may also join by applying directly to the Secretary of the Navy League of the United States, 32 Broadway, New York. The annual dues are one dollar, which entitles a member to receive all publications of the League, including the Navy League Journal, a handsomely illustrated and well written monthly, the first number of which has just been issued, and which will be devoted to the interests of the League and of the Navy. The principal officers of the Navy League of the United States are Gen. Benjamin F. Tracy, late Secretary of the Navy, president; Hon. William McAdoo, late Assistant Secretary of the Navy, vice-president; Geo. B. Satterlee, secretary; Allen S. Apgar, treasurer; and there is also a distinguished list of honorary vice-presidents, directors, founders and life members.

—At the annual meeting of the Allis-Chalmers Co., of Chicago, the following officials were elected: Chairman of the board of directors, Elbert H. Gary; president, Charles Allis; vice-president and treasurer, William J. Chalmers, second vice-president, Henry W. Hoyt; third vice-president, Philetus W. Gates; fourth vice-president and secretary, Joseph H. Seaman; assistant secretary, Joseph O. Watkins. The consulting engineer is Edwn Reynolds, and the chief engineer, Irving H. Reynolds. The chairman reports that the development of the business of the company during the past year has been most satisfactcory, particularly in various lines not hitherto given special attention, thus giving the company in the diversity of its products broader fields for its manufactures and greater stability for its industries. Its principal departments are now classified and its works specialized for the manufacture of steam, gas, blowing, pumping and hoisting engines, compressors and complete installations of electrical power stations, mining, metal reducing, sawmill, flour-mill, crushing, cement, waterworks and sugar machinery. The increased volume of work on hand, the extent and variety of that offered, and the enlarged facilities for its production, constitute assurances of business that justify the stockholders, as well as the management, in expecting satisfactory results for the current year.

—The Canadian General Electric Company, Ltd., Toronto P. O., Canada, is now representing the Electric Storage Battery Co. in the sale of the Chloride accumulator and the Exide accumulator throughout Canada, and all inquiries from Canada in regard to storage batteries should be addressed to the Canadian General Electric Co., Ltd..

—The A. Leschen & Sons Rope Company, the manufacturers of wire rope and aerial wire-rope tramways, have moved their San Francisco office to the Rialto Building, corner of New Montgomery and Mission Streets. Their other offices remain as heretofore, namely: 920-922 North First St., St. Louis, Mo. (the home office); 137 East Lake St., Chicago; 92 Centre St., New York; 1717-1723 Arapahoe St., Denver, Col.

—The Faraday Society, an organization to promote the study of electrochemistry, electrometallurgy, chemical physics, metallography and kindred subjects, has recently been formed in London, with the following list of officers: President, J. W. Swan; vice-presidents, Prof. A. Crum-Brown, Lord Kelvin, Sir Oliver T. Lodge, Ludwig Mond, Lord Rayleigh, Alexander Siemens, James Swinburne; treasurer, F. Mollwo Perkin; council, George Beilby, Bertram Blount, A. G. Charleton, W. R. Cooper, Sherard Cowper-Coles, F. G. Donnan, Prof. A. K. Huntington, R. A. Lehfeldt, W. S. Squire, O. J. Steinhart; secretary, F. S. Spiers, 82, Victoria street, London, S. W. Papers will be printed and circulated among members before being read at a meeting; and, with the very laudable object of avoiding increasing the number of existing publications, the council has made arrangements to publish the proceedings of the Society in *The Electro-Chemist and Metallurgist*, which will be issued monthly, free to members.

—Westinghouse, Church, Kerr & Co. have recently received orders for additional boiler and economizer equipments for the Detroit plant of the Solvay Process Co. The Solvay Co. operates, at Detroit and Syracuse, N. Y., two of the largest chemical establishments in the United States. The Detroit plant is located at Delray, a suburb on the Detroit River, and near the enormous salt deposits occurring in the marshland at this point. Steam power is furnished from a central boiler plant, which at present aggregates 7,200 H. P. Roney mechanical stokers are used throughout, and the several batteries of boiler are also equipped with Roney high-pressure, circulating-type economizers. The plant is laid out in batteries of six boilers each. The additional equipment will consist of a new battery comprising six 300-H. P. Babcock & Wilcox water-tube boilers fitted with Roney stokers, together with four additional economizers, two of which will complete the equipment of a previously installed battery. A conspicuous feature of this plant is a massive brick stack 16 feet in diameter and 260 feet in height.

Mr. W. N. Durant, of Milwaukee, the manufacturer of counting machines, is sending a neat and convenient envelope opener to his friends and customers.

—The Keystone Drop Forge Works have moved to their new plant at Chester, Pa., where they will have largely increased facilities for business.

—The Crescent Iron Works, of Springfield, Mo., the Sterling Iron Works, of Springfield, Mo., and the Aurora Foundry & Machine Works, of Aurora, Mo., have consolidated all their business, property, and interests under the name of the United Iron Works Co. The general offices of the new company will be at Springfield, Mo., and the management will be as follows: C. H. Cole, president; H. T. Hornsby, vice-president and general manager; R. P. Bowyer, secretary; A. C. Daily, treasurer; C. C. Mathey, general superintendent; A. M. Fowler, assistant general superintendent. The following are the plants acquired by the consolidation: The Crescent Iron Works, Springfield, Mo.: the Sterling Iron Works, Springfield, Mo.; the Aurora Foundry & Machine Works, Aurora, Mo.; and the Aurora Foundry & Machine Works, Iola, Kan. In addition to these the new company has purchased outright the complete plant and stock of the Pittsburg Foundry & Machine Co., of Pittsburg, Kan., and will operate the latter in connection with the other properties.

—The Columbia Engineering Works, Inc., have taken up the manufacture of the Arthur Herschmann patent steam wagons, and are building three-ton and six-ton capacity trucks. In order to give special attention to this industry on automobile department has been established, and the shops equipped with additional tools especially adapted for this work; and upon application to the Columbia Engineering Works, Inc., William and Imlay streets, Brooklyn, N. Y., catalogues and particulars can be secured.

—The Jeffrey Manufacturing Co., of Columbus, Ohio, recently gave the eighteenth annual outing to their employees at Olentangy Park, where everybody had a good time which lasted all day and evening.

—Both the iron foundry and the new steel plant of the Diamond Drill & Machine Co., of Birdsboro, Pa., continue to run night and day, and they are shipping castings in from one to four weeks. Despite their present excellent facilities for turning out work by their modern methods and equipment, it has been found necessary to build another open-hearth furnace to accommodate the large and ever increasing volume of business. Their machine shop also shares in the general prosperity, making Birdsboro, one of the busiest towns of its size in the state.

—One of the large trunk lines has just placed an order for about 10,000 tons of heavy steel rails for the Pacific Coast. The well known house of Arthur Koppel, 66-68 Broad street, New York City, has been successful in securing this order, as well as several other large ones for other roads.

—The Ericsson Telephone Company, of 296 Broadway, New York, have recently installed one of the handsomest and most efficient multiple switchboards in the South. It is built for the magneto system, and fitted with new combination indicator jacks that have been recently patented. Experts from all over the country agree that this appliance is the most ingenious, compact, simplest and strongest on the market, and one that insures very rapid service. The board is installed for 1,200 numbers, and has a capacity for 3,000. The main distributing rack for 1,200 numbers is fitted with carbon lightning arresters and heat coils; a monitor desk, with visuals for calling and clearing, and jacks for listening was also installed. The woodwork on this board is made of mahogany, with heavy piano finish, giving it a very fine appearance.

—The Chandler & Taylor Co., of Indianapolis, have recently brought out a new line of direct-connected, automatic cut-off steam engines of the enclosed type, built strictly in accordance with the recommendations made by the American Society of Mechanical Engineers and the American Institute of Electrical Engineers for direct-connected units of this kind.

—Wm. B. Scaife & Sons Co., of Pittsburg, Pa., sole manufacturers of the We-Fu-Go and Scaife water-softening and purifying systems, have found it necessary to build an addition to their present plant at Oakmont, Pa., to accommodate their increased business in this line, and have just completed the erection of a new shop 60 feet wide by 100 feet long, equipped with the latest improved machinery, which will be used exclusively for manufacturing the We-Fu-Go and Scaife systems, in addition to their present shops. They have at the present time systems aggregating 95,000 H. P. under construction for steam boiler plants, in addition to plants for softening water to be used in manufacturing processes such as dyeing and bleaching in woolen and cotton mills, and for washing in laundries.

—The America Steam Gauge and Valve Mfg. Co., of Boston, gave their annual dinner to the members of their sales department on the evening of July 1st. Every year the traveling salesmen, the branch house managers, and the home office staff have a gathering at which the business of the company is thoroughly discussed, the meeting ending with a dinner. Among those present this year were: John McCandlish, R. B. Phillips, J. L. Weeks, W. E. Jerauld, H. B.

Nickerson and James Chambers, of Boston; U. H. Nickerson, Providence, R. I.; H. A. Crocker, Buffalo, N. Y.; Chas. Kilander and M. B. Hicks, Chicago; Richard Hewins, Philadelphia; Horace Parker, Atlanta, Ga.; Chas. A. Allen, New York; and Thos. M. Kelly, Cincinnati.

—On the application of the Merchants' Association of New York, after the Southwestern Excursion Bureau had officially declined to grant rates to New York, the Southern Pacific Co. has put in an individual special rate from Texas to New York for the fall buying season. The special merchants' fare of one and one-third for the round trip over the Southern Pacific and its affiliated lines will be in effect on July 31st-August 4th, inclusive, and August 21st-25th, inclusive, via the New Orleans gateway, on the certificate plan. The return limit on the certificates will be thirty days from date of issuance. The Southern Pacific Co. has also agreed to make the same reduced rate from points reached by its system in Texas, in connection with the water trip to New York from New Orleans on the Southern Pacific new passenger steamships. The special fare of one and one-third by rail and steamer also covers meals and stateroom while on board the boat. The Merchants' Association will send to Texas merchants in about two weeks the circulars giving full particulars as to the rates, dates, routes, etc.

—The forty-first annual outing tendered to their employees by the Lunkenheimer Company, of Cincinnati, was held at Woodsdale Island Park on Saturday, July 18th. Seven hundred employees and their families, or, in all, about two thousand people, including children, took part in the excursion, and enjoyed the many amusements that had been provided for them by the company, which assumed the entire expense. Woodsdale Island Park is about thirty-one miles from Cincinnati, and it required two railway trains of ten coaches each, to transport the excursionists.

—Wyman and Gordon, of Worcester, Mass., the manufacturers of drop and special forgings, have been increasing their business so greatly to the westward of New York, that in order to meet the demands upon them they have purchased property in Cleveland, which is bounded by Superior, Wason and St. Clair Streets, and has a frontage of 600 feet on the C. & P. Railroad. Plans are being made for extensive buildings to occupy the entire lot, so designed that they may be erected in sections as the business requires. While it is proposed to begin with a medium-sized plant, it will be conveniently arranged and will be equipped with the best forging machinery that can be procured, and will be enlarged as occasion warrants. The main office of Wyman and Gordon will remain at Worcester.

—The American Blower Co., of Detroit, Mich., have recently secured the order for three heating outfits to be installed in the new factory of the Packard Motor Car Co., of their own city; they also have orders upon their books for apparatus to be installed in the factory of Pettibone, Milliken & Co., Chicago; the Jas. Leffel Co., Springfield, O.; and the B. & O. round house at Keyser, W. Va.

—At a series of receptions recently tendered by the management of Armour Institute of Technology to the students of the American School of Correspondence, Dr. Gunsaulus, President of Armour Institute, presided, and the famous correspondent of the Chicago *Record-Herald*, Mr. Wm. E. Curtis, was one of the speakers. Mr. Curtis was so impressed with the earnestness of the 3,000 students who attended, by the character of the instruction given, and by the possibilities of this so-often-scoffed-at plan of education for wage-earners, that in the June 29th issue of the *Record-Herald* he devoted his regular daily letter to a description of the work of correspondence schools, under the title of "Education by Mail." It has been the constant aim of the management of the American School of Correspondence to raise the standard of correspondence instruction in general to the plane of serious educational work. All the officers and instructors of the school are college men, graduates from such institutions as the Massachusetts Institute of Technology, Harvard, Tufts College, Lehigh University, Dartmouth, and Armour Institute of Technology. They are men fitted by experience and education to offer sound instruction, and they are men whose sense of responsibility to their alma mater will not permit them to hold any but the highest educational ideals and standards.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Air Compressors.

Catalogue, with descriptions and illustrations of air and gas compressing machinery of every style for compressing air or gas for any purpose, pumping natural gas fields, producing dry vacuum, operating air-lift well pumps, etc.; and also of direct-acting steam pumps and other power pumps; together with useful tables and data. 9 by 6 in.; pp. 96. Hall Steam Pump Company, Pittsburg, Pa.

Briquetting Machinery.

General catalogue, No. 5, with illustrations and descriptions of modern machinery and methods for briquetting flue dust, fine ores, calcines, concentrates and other mineral fines, and blue prints giving elevations and plans of briquetting plants. 8 by 10 in.; pp. 21. Chisholm, Boyd & White Co., Chicago.

Conveying Machinery.

Catalogue No. 035, with descriptions and many illustrations of coal-handling and conveying machinery of every description, electric hoists and locomotives, narrow-gauge railways and cars, and other kinds of mechanical-handling apparatus. 9 by 6½ in.; pp. 18. Also, catalogue No. 032, devoted to foundry ladle cars for transporting and distributing molten metal. 9¼ by 6¾ in.; pp. 4. C. W. Hunt Company, West New Brighton, Staten Island, N. Y.

Diamond Drills.

Catalogue No. 15, entitled "The Diamond Drill and Its Work," with illustrations, descriptions and price lists of diamond-pointed core drills for prospecting for minerals, and testing foundations of bridges, dams, buildings and other engineering works, with lists of parts and their weights, methods of operation, records of work performed and testimonials. 9¼ by 6 in.; pp. 78. American Diamond Rock Drill Co., 95 Liberty St., New York.

Electric Apparatus.

Bulletins, catalogues and price lists, and other pamphlets illustrating and describing controllers, arc lamps, railway line material, transformers, switchboards, meters, switches, manhole junction and fuse boxes, motors, generating sets and other kinds of electric machinery and apparatus. General Electric Company, Schenectady, N. Y.

Electric Driving.

Leaflets Nos. 100, 101, 102 and 103, showing Northern electric motors driving, respectively, a Williams cement mill, a Bickford portable radial drill, a Troy collar and cuff ironer, and a 28-inch Pond lathe. 6¼ by 3½ in.; pp. 4. Northern Electrical Mfg. Co., Madison, Wis.

Exhaust Fans.

Sectional catalogue No. 149, with illustrations and descriptions of "A B C" exhaust fans for the removal and conveying of shavings and dust, elevating and distributing of cotton and wool, removal of smoke and fumes, and for use in connection with special heating and drying plants, together with auxiliary apparatus. 9 by 7¼ in.; pp. 58. American Blower Company, Detroit, Mich.

Fillet Tool.

Booklet, with illustrations and description of Rabiger's patent fillet tool, for cutting a perfect fillet of any radius in shafting, rolls and machinery of all descriptions, and for use on lathes, planers, shapers, boring mills and other machine tools, as well as for pattern making and wood working of all kinds, and for spinning sheet metal. 6 by 3½ in.; pp. 7. Rabiger Bros. & Co., Philadelphia.

Gas-Works Machinery.

Pamphlet 118, containing an illustrated article, by P. Plantinga, on "Gas Purifiers and Purification," reprinted from the *American Gas Light Journal*, and pamphlet No. 129, devoted to ammonia concentrators for saving volatile and fixed ammonia compounds in gas liquor. 9 by 6 in.; pp. 16 and 4. The Gas Machinery Co., Cleveland, Ohio.

Induction Motors.

Circular No. 1062, devoted to induction motors for variable speed, with illustrations and descriptions of the machines and their parts, curves showing their operation and other useful information. 10 by 7 in.; pp. 32. Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Injectors.

Catalogue, illustrating and describing various types of Walworth locomotive injectors for the proper and economical feeding of locomotive boilers, Walworth stationary and Dodge automatic injectors. 8 by 6 in. pp. 22. Walworth Manufacturing Co., Boston, Mass.

Iron-Works Machinery.

Circulars, illustrating and describing lever shears for cutting steel bars, etc.; straightening machine, with rolls grooved to suit requirements; and slow-speed gear or portable roll lathe, for turning rolls in their housings. 11 by 8½ in.; pp. 5. Vulcan Foundry & Machine Co., New Castle, Pa.

Machine Tools.

Catalogue No. 4, in flexible cloth cover, with descriptions and half-tone illustrations of engine lathes, upright drill presses, radial drills, and other high-grade machine tools and their parts and accessories. Also, shipping weights and instructions and telegraphic code. 9 by 6 in.; pp. 187. The Hamilton Machine Tool Co., Hamilton, Ohio.

Marine Machinery.

Catalogue No. 16, with illustrations and descriptions of triple-expansion, compound and other styles of marine engines, marine boilers, paddle- and stern-wheel machinery, screw propellers, and other kinds of marine machinery, 9 by 6¼ in.; pp. 48. Marine Iron Works, Chicago.

Paint.

Folder, entitled "Colors and Specifications," illustrating five kinds of high-class steel and iron construction painted and protected with Dixon's silica-graphite paint, and showing the four colors recommended for use. 6¼ by 3½ in.; pp. 6. Joseph Dixon Crucible Co., Jersey City, N. J.

Pamphlet describing Galvanum, a paint that will adhere permanently to galvanized iron, with illustrations of many buildings and other structures where Galvanum has been used with success, and testimonials. 8 by 11 in.; pp. 12. The Goheen Manufacturing Company, Canton, Ohio.

Pipe.

Catalogue, bound in flexible cloth, with illustrations and descriptions of Taylor's spiral, riveted, steel pipe, made in sizes from 3 to 40 inches in diameter, and all kinds of pipe fittings, and useful data on hydraulics. 8¼ by 4 in.; pp. 40. American Spiral Pipe Works, Chicago.

Recording Instruments.

Large catalogues Nos. 9 and 10, devoted, respectively, to the latest styles of recording pressure and vacuum gauges, and recording volt, ampere and watt meters. These well known and successful instruments are fully illustrated and described, and full-size views are shown of the charts and the different kinds of graduations. Price lists and testimonials. 11½ by 9 in.; and 12 by 9½ in.; pp. 16 and 32. The Bristol Company, Waterbury, Conn.

Rock Drills.

Pamphlet describing and illustrating the Water Leyner rock drill and its operation. In this drill the piston and tool are entirely disconnected, and the cuttings are forced from the hole by compressed air and water discharged through the tool, thus giving efficient and economical operation, with entire absence of dust. 9 by 6 in.; pp. 30. The J. Geo. Leyner Engineering Works Co., Denver, Colo.

Saw Table.

Catalogue A, with half-tone illustrations and descriptions of the new Colburn universal saw table for wood-working, which combines many novel and distinctive features and is built like a machine tool. 9 by 6 in.; pp. 19. Colburn Machine Tool Co., Franklin, Pa.

Screw-Cutting Tools.

Catalogue and price list No. 17, with illustrations and descriptions of stocks, dies, taps, screw plates with adjustable dies and guides, the Oster patent gauge or stop, and other kinds of screw-cutting tools for threading pipes and bolts, and of hand and power machines for threading and cutting off pipe. 8½ by 5½ in.; pp. 35. The Oster Manufacturing Co., Cleveland, Ohio.

Screw Machines.

Catalogue, with descriptions and half-tone illustrations of the Acme multiple-spindle full-automatic screw machines and semi-automatic screw-slotting machines, their parts and their products. In these machines all tools act simultaneously and screws are turned out with great rapidity. 6 by 9 in.; pp. 50. The National-Acme Manufacturing Co., Cleveland, Ohio.

Shaper.

Pamphlet describing and illustrating a universal shaper which is adapted to all classes of intricate punch and die work, and metal pattern and jig making. 9 by 6 in.; pp. 10. Cochrane-Bly Machine Works, Rochester, N. Y.

Steam Engines.

Catalogue No. 61, a partial list of users of the Reynolds-Corliss steam engines, built at the Edward P. Allis Works, Milwaukee. The list is a very impressive one, as these engines are employed for a great variety of purposes and are in operation in all parts of the United States as well as in many other countries in every quarter of the globe. 4¼ by 6 in.; pp. 189. Allis-Chalmers Company, Chicago.

Large catalogue, with full-page half-tone illustrations and descriptions of Bates-Corliss steam engines, air- and gas-compressing machinery, and plants where these machines are installed. 9 by 12 in.; pp. 73. Bates Machine Co., Joliet, Ill.

Steam Traps.

Pamphlet No. 152, with illustrated descriptions and prices of the Morehead return traps and tank traps for effectively handling the condensation water in steam plants, showing their operation and many advantages. 9 by 7 in.; pp. 16. American Blower Company, Detroit, Mich.

Tortilla Mills.

Catalogue 62-E with descriptions, illustrations and prices of hand and power tortilla mills, in various styles, for grinding dry or wet corn and other substances, corn and cob mills, and corn shellers and separators. 3½ by 6½ in.; pp. 22. The Geo. L. Squier Mfg. Company, Buffalo, N. Y.

Water-Wheel Governor.

Circulars, with illustrated descriptions of Replogle's duplex relay water-wheel governor and relay-returning water-wheel governor, for closely regulating the speed of water-power plants, and curves showing very satisfactory test of a new relay governor at a plant which furnishes current for an electric railway, at Matteawan, N. Y. 11 by 9 in.; pp. 4. The Replogle Governor Works, Akron, Ohio.

Wheels.

Pamphlet describing and illustrating the solid forged and rolled steel wheel for railway rolling stock, and its process of manufacture, with the special machinery used for this purpose. 6¼ by 9 in.; pp. 17. Schoen Steel Wheel Company, Pittsburg, Pa.

News Supplement

The Engineering Magazine—September, 1903

Coming Society Meetings.

American Institute of Electrical Engineers. Sec.: Ralph W. Pope, 95 Liberty St., New York. Regular meeting on fourth Friday of each month, except June, July and August, 12 W. 31st St., New York.

American Institute of Mining Engineers. Sec.: R. W. Raymond, 99 John St., New York. Next meeting, October 13, at New York.

American Mining Congress. Sec.: Irwin Mahon, Carlisle, Pa. Annual congress, September 7-12, at Deadwood and Lead, South Dakota.

American Railway Association. Sec.: W. F. Allen, 24 Park Place, New York. Next meeting Oct. 28, at Richmond, Va.

American Railway Mechanical and Electrical Association. Sec.: Walter Mower, Detroit. First annual meeting, Sept. 1-4, Saratoga Springs, N. Y.

American Society of Civil Engineers. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August.

American Street Railway Association. Sec.: T. C. Penington, 2020 State St., Chicago. Annual meeting, Sept. 2-4, Saratoga Springs, N. Y.

Association of Edison Illuminating Companies. Sec.: W. H. Johnson, Philadelphia. Convention, September 8-10, at the Thousand Islands, N. Y.

Association of Railway Superintendents of Bridges and Buildings. Sec.: S. F. Paterson, Concord, N. H. Annual convention, Oct. 20, Quebec.

Boston Society of Civil Engineers. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

Canadian Railway Club. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

Canadian Society of Civil Engineers. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. Regular meetings every alternate Thursday from October to May, inclusive.

Central Railway Club. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Fridays of Jan., March, May, Sept. and Nov., Hotel Iroquois, Buffalo.

Central States Water Works Association. Sec.: Wm. Allen Veach, Newark, O. Annual convention, September 15-17, at Dayton, O.

Chicago Electrical Association. Sec.: W. J. Warder, Jr., 900 Warren Ave. Regular meetings on first Friday of each month, from October to May.

Civil Engineers' Club of Cleveland. Sec.: Arthur A. Skeels, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

Civil Engineers' Society of St. Paul. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

Engineering Association of the South. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

Engineers' Club of Chicago. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

Engineers' Club of Cincinnati. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Saturday of each month, except July and August.

Engineers' Club of Columbus (Ohio). Sec.: H. M. Gates, 12½ North High St. Regular meetings on third Saturday of each month, except July and August.

Engineers' Club of Minneapolis. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month.

Engineers' Club of. Philadelphia. Sec.: J. O. Clarke, 1122 Girard Street. Regular meetings on first and third Saturdays of each month, except July and Aug.

Engineers' Club of St. Louis. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

Engineers' Society of Western New York. Sec.: L. W. Eighmy, 13 City Hall, Buffalo. Regular meetings, first Tuesday of each month, except July and August.

Engineers' Society of Western Pennsylvania. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

Franklin Institute. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. Regular monthly meetings of the various sections on other days.

International Association of Municipal Electricians. Sec.: Frank P. Foster, Corning, N. Y. Meeting, September 2-4, Atlantic City, N. J.

Iowa Railway Club. Sec.; P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

League of American Municipalities. Sec.: John MacVicar, Des Moines, Iowa. Seventh annual convention, Oct. 7-9, at Baltimore.

Louisiana Engineering Society. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

Montana Society of Engineers. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturdays.

New England Railroad Club. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

New England Water Works Association. Sec.: Willard Kent, 715 Tremont Temple, Boston. Annual convention, September 9-11, at Montreal.

New York Electrical Society. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on Wednesdays.

New York Railroad Club. Sec.: F. M. Whyte, Grand Central Station, N. Y. City. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

North-West Railway Club. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

Pacific Coast Railway Club. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at different cities.

Pacific Northwest Society of Engineers. Sec.: G. F. Cotterill, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

Railway Club of Pittsburg. Sec.: J. D. Conway, P. & L. E. R. R, Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

Railway Signaling Club. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov. Annual meeting, Nov. 10, at Detroit.

Richmond Railroad Club. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

Roadmasters' and Maintenance of Way Association. Sec.: Chas. McEniry, Cedar Rapids, Iowa. Annual meeting, Oct. 13, 14 and 15, at Kansas City, Mo.

Rocky Mountain Railway Club. Sec.: J. E. Buell, 906 20th Ave., Denver. Regular meetings on first Saturday after the 15th of each month.

St. Louis Railway Club. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

Society of Chemical Industry, New York Section. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, at Chemists' Club, 108 W. 55th St.

Southern and Southwestern Railway Club. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov., at Atlanta.

Technical Society of the Pacific Coast. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

Texas Railway Club. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

Traveling Engineers' Association. Sec. W. O. Thompson, Oswego, N. Y. Next meeting, Sept. 8, Chicago.

Western Railway Club. Sec.: Jos. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

Western Society of Engineers. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

Mr. Emile Guarini, of Brussels, the well-known inventor and writer on electrical subjects, has designed an ingenious system for sending alarms of fire or notices of excessive rises of temperature by means of an automatic wireless-telegraph apparatus to any point desired and from any number of stations.

Mr. W. O. Duntley, vice-president and general manager of the Chicago Pneumatic Tool Co., has gone on a trip to the Pacific Coast in the interests of his company.

—Mr. Jas. Alex. Smith, of Melbourne, Australia, recently read a paper before the Victorian Institute of Engineers, entitled: "Notes on Internal Flow in Centrifugal Pumps. Part II. A Study of the Theory of the Runner." This paper is a continuation of one read last year before the same society, and treats the subject by analytical and experimental methods on lines differing radically from those usually followed.

Industrial Notes.

The recent launch of the "Mongolia" from the yards of the New York Shipbuilding Co., at Camden, is noteworthy on account of the size of the vessel—26,530 tons displacement, 14,000 tons dead weight carrying capacity. This is the largest ship ever built on the Delaware, and a good-sized vessel anywhere, even in these days of marine giants. As first laid down, she was designed for the Atlantic Transport Co., but she was transferred to and completed for the Pacific Mail Co. The many attendant changes make her speedy completion the more noticeable, even considering the unusual equipment and facilities of the New York yards. The vessel is of the five-deck type, 615 by 65 by 51 feet, 12,000-horsepower, 16 knots; she is fitted with powerful steam steering and cargo-handling gear, cold storage, electric lighting, and especially complete ventilating apparatus. Steam is supplied by four double-ended and four single-ended Scotch boilers with Morrison corrugated furnaces, designed for 215 pounds working pressure, heated forced draught. The "Manchuria," a sister ship, is just about to be launched.

The American Conduit Co., of Los Angeles, Cal., the manufacturers of electrolysis-proof bituminized fibre conduits, have opened an office at 170 Broadway, New York, which will be in charge of Mr. F. C. Mott.

Within the past two years the R. D. Nuttall Company have expended a large sum for new machinery so that they could properly take care of their rapidly increasing trade, and now again they find it necessary to install 23 of the latest type gear-cutting machines as well as additional worm-gear machinery, mills. lathes, etc., to correspond. In regard to the new gear-cutting machinery, they have good reasons to believe that this is the largest individual order for this type of machine ever placed. They have also made a corresponding increase in the capacity of their power plant, and when all of the above machinery is in place, they will be operating what is probably the largest and most complete gear-cutting plant in the world.

The Omega Steel Co., of New Haven, Conn., report some very satisfactory tests of their milling cutters. At the Union Switch and Crossing Co., Swissdale, Pa., a cut 1/16 inch deep, 5/8 inch wide and 7 inches long was made on Braeburn unannealed cast steel with a milling cutter 1¾ inches in diameter and having a 2½-inch face. The cutter ran 360 revolutions and had a feed of 9½ inches per minute. At the Mesta Machine Co., West Homestead, Pa., a cutter was used which was 1¾ inches in diameter, and had a 1¾-inch face and a 7/8-inch hole. The speed was 160 revolutions per minute and the feed .036 inch per revolution. The cut, which was made on two cast-steel dies for a bolt cutter, was 1/16 inch by 1¼ inches by 5 inches, and the cutter stood the trial without injury. Still other tests were made at the Bickford Drill Co., Cincinnati, where the dimensions of the milling cutter were: diameter, 1¾ inches; face, 1¾ inches; hole, 7/8 inch. The cutter was run at 372 revolutions, with a feed of 1 inch per minute. A cut was made in machine steel 1¼ inches wide, 1/16 inch deep and 7 inches long, and in cast iron a similar cut 14 inches long, the cutter not being harmed in any way by its performance.

The Ingersoll-Sergeant Drill Company, which has placed a line of pneumatic tools on the market, reports immediate recognition of the superiority of the Haeseler "Axial Valve" hammers, upon comparative tests with other tools. Among the latest purchasers of these tools are: Niles-Bement-Pond Company; Ramapo Iron Works; MacPherson Switch & Frog Company; Creswell & Waters Company; Warren Foundry & Machine Works; Chicago, Rock Island & Pacific R. R.; Brown Hoisting & Conveying Machine Company; Howard Iron Works, and International Boiler Works Company.

In looking up the subject of durability and length of life of superheaters American engineers have generally been confronted with the necessity of turning to Europe for such experience as would give confidence in this form of apparatus. But it is interesting to note that the Hartford Electric Light Co. over two years ago installed a Foster superheater in connection with a 600-H. P. water-tubular boiler and a Westinghouse-Parsons steam turbine, and have as the result of their experience, recently placed an order with the Power Specialty Company of New York, for a duplicate plant.

The Bureau of Forestry is about to make a series of tests to determine the strength and durability of the principal merchantable timbers of the United States, on a larger scale than that of the former tests which were in charge of the late Prof. J. B. Johnson. The officials of the Bureau fully realize that this work, which is the result of a wire-spread and urgent demand, should not be undertaken until its scope and methods have been thoroughly considered. To be thoroughly effective the plan of work should have the endorsement of leading engineers and manufacturers. This Bureau is especially anxious to get results whose authority will be unquestioned, and it has issued a circular which contains a tentative plan for future work. Copies of all publications relating to timber tests already made by the Division of Forestry will be sent with the circular to persons who are interested in this work. A full discussion of the plan for the proposed tests, and criticisms or suggestions as to its scope and methods, are generally desired. The value of the proposed investigations to engineers, foresters, lumbermen, builders, architects, and manufacturers will be greatest if a logical and systematic scheme of this kind is applied in the testing, the scope and technique of which should be fixed only after a full discussion.

An interesting proof of the progress of electrical industries is the recent shipment of a carload of electricity wattmeters (some 1,400 in number) by the Stanley Instrument Company, of Great Barrington, Mass., through Messrs. John Martin & Co., San Francisco, their Pacific Coast agents, to the Edison Electric Co., of Los Angeles, Cal. The shipment, intended for the measurement of current used in the comparatively small installations of general house lighting aggregates a total capacity of upwards of 3,000 H. P., and while the instruments are small, the total weight of the shipment is nearly 40,000 pounds. The destination, Los Angeles, California, indicates the wide-spread use of electrical apparatus of the highest class. The wattmeters of the Stanley Instrument Co., besides being shipped to all parts of the United States, have been sent for years to South America, Mexico, Porto Rico, etc., and since the beginning of this year, when an office was established at No. 23 Boulevard des Italiens, Paris, France, by this company, a strong demand for their wattmeters has arisen in France, Italy, Switzerland, Germany, Austria, Hungary, England and the British possessions, a pleasing manifestation of the high position obtained by American electrical manufacturers.

The Peterborough Hydraulic Power Company, of which Senator Geo. A. Cox in president, is building a new power plant on the Otonabee River in the town of Peterborough, Ontario, Canada, which will be equipped with the following apparatus recently purchased from the Westinghouse Electric & Manufacturing Company: A 1,500-kilowatt, 2,240-volt generator, having 7,200 alternations and running at 150 revolutions per minute, to be direct connected to water wheels; two 125-volt direct-current, direct-coupled exciters of 75 kilowatts capacity each; together with a switchboard consisting of a large generator panel and two exciter panels. This power house, when completed, will be an unusually fine one and is to furnish power to the Peterborough mill of the American Cereal Company, owned by the Quaker Oats Company; Power will be supplied to several other manufacturing plants in the town and also to the Peterborough Light & Power Company, which does the electric lighting and small-power business in Peterborough.

The Allis-Chalmers Co., of Chicago, report the following partial list of engine sales for July: Chicago Beach Hotel, Chicago; Knox Construction Co., Chicago; Richmond Cedar Works, Richmond, Va.; Barrett Mfg. Company, Beloit, Wis.; American Aristotype Co., Jamestown, N. Y.; Stilwell-Bierce & Smith-Vaile Co., Dayton, O.; Fourche River Lumber Co., Chicago; J. I. Case Plow Works, Racine, Wis.; Consumers' Heat & Electric Co., Bloomington, Ill.; Union Sugar Company, San Francisco, Cal.; Canton Oil Mill Co., Canton, Miss.; Mr. Henry Du Pont, Wilmington, Del.; Olds Motor Works, Lansing, Mich.; The Clayton Oil Mills, Clayton, N. C.; The Homestake Mining Co., Lead, So. Dak.; Lacey-Buek Iron Co., Birmingham, Ala.; C. A. Macdonald, Chicago; Arkansas City Milling Co., Arkansas City, Kan.; Manhattan Rubber Mfg. Co., Passaic, N. J.; Charles B. Pride, Appleton, Wis.; Columbus Buckeye Lake & Newark Traction Co., Columbus, O.; Lock, Moore & Co., Ltd., Westlake, La.; Georgia Cordage Mills, Decatur, Ga.; Marquette Cement Mfg. Co., La Salle, Ill.; Coe Brass

Mfg. Co., Torrington, Conn.; Charles Waite, South Dakota; The Gauley Company, Camden-on-Gauley, W. Va.; Rock Hill Water, Light & Power Co., Scranton, Pa.; Memphis Consolidated Gas & Electric Co., Memphis, Tenn.

The Gisholt Machine Company, of Madison, Wis., has recently amended its articles of incorporation, increasing its capital to $750,000. Up to the present time the Gisholt Company has confined itself almost exclusively to the manufacture of the now well known Gisholt lathes. These tools are made in several varieties and sizes and the line is being constantly extended. The increasing business in Gisholt lathes has necessitated a very considerable increase in the manufacturing facalities of the company, and additions have recently been made, both in buildings and equipment, that will double the former capacity of the plant. While the new buildings and equipment will be largely used for producing Gisholt lathes, they will, in part, be used for the manufacture of other types of machine tools, such as boring mills, etc. The last named machines, however, will not be manufactured on a large scale until new buildings now in contemplation are completed. Contracts have recently been made by the Gisholt Company for a large new foundry, to be equipped throughout with modern, up-to-date appliances. The building will be strictly fire-proof.

A recent testimony to the value of flexible metallic conduit was made by Vice-President and General Manager Bryan of the Interborough Rapid Transit Company in an interview published in the New York *Sun*, August 12th. Speaking of the fire-proof construction of the new cars for the subway, and the impossibility of the Paris accident being repeated in New York, he says, according to the N. Y. *Sun*: "The wiring for lighting the cars is one roof away from the passengers. Two small wires are insulated with asbestos and carried in conduits of flexible metal." The flexible metallic conduit which he refers to is that manufactured by the Sprague Electric Company, who received the order for this type of conduit for the Interborough car wiring for lights. This type of conduit is unequalled for car wiring as well as the wiring of buildings where thorough protection to wires and insulation is essential. Its flexibility is such that it can be bent around corners and over obstructions with ease, the energy required to bend it being no more than is required to bend a manila rope of the same diameter. No elbows, therefore, are required and the installation is reduced to absolute simplicity. It is self-evident that this type of conduit is well fitted to car wiring, and it is gratifying to note that the Interborough Company has taken a step forward in the hitherto careless methods of car wiring, which will insure the greatest possible safety to passengers against fire due to defective wiring.

The Duke of Marlborough, following the example of other progressive members of the British aristocracy, has ordered two electric elevators with push-button control from the Otis Elevator Company. These are to be installed in his city home, Blandford House, Curzon St., London.

The Robbins & Myers Company, of Springfield, Ohio, have been manufacturing and selling a line of direct current electric motors and dynamos, from 15 H. P. down to the smallest sizes, for about six years. All sizes of these machines have been designed on similar lines, following an ideal type for general application. When this type first appeared, it was as the exponent of a new idea in motor building—that of complete protection of armature and windings from mechanical injury, without interfering with the ventilation necessary to cool running. The type was expected to fill a place midway between the open, unprotected motor, which was the standard practice at that time, and the full enclosed motor, which required so much material per horse-power of output in order to run within a safe temperature limit. The history of subsequent motor building has justified the belief of the designers of these machines, for at present the large majority of all motors sold, under 25 H. P., either embody or point with respect to this idea of a protective design. The Robbins & Myers Company have from the first advertised these machines as being of "Our Protected Type," but many of their customers have pointed out to them that this title is no longer sufficiently distinctive, and have suggested that they adopt some name which shall apply to motors and dynamos of their manufacture only. In pursuance of this idea, the name "Standard," so long used by them as applying to their electric fans, and for this reason so intimately associated in the minds of the public with the name of The Robbins & Myers Company, seems peculiarly appropriate. They are aware of the fact that the name "Standard," as applied to dynamo-electric machinery, is not new, but they are not aware that it is now being applied by any maker of direct-current dynamos and motors now in business, and this is to notify such makers, if they exist, and the public at large, that unless they hear in the meantime that the name has been pre-empted, The Robbins & Myers Company will expect all their products to be known as "The Standard," after September 1st, 1903.

The old and well known firm of Thos. H. Dallett & Co., of Philadelphia, has lately been reorganized and incorporated as the Thos. H. Dailett Co., with officers as follows: President, Thos. H. Dallett; vice-president and general manager, Ernest C. Bliss; secretary and treasurer, E. C. Clay; with W. H. Van Sickel, lately New York representative of the Under-Feed Stoker Co. of America, and formerly identified with the pneumatic tool industry, as superintendent. The company will greatly extend and enlarge the capacity of their plant, located at York Street and Sedgely Avenue, and while continuing the manufacturing of their well known belt and electrically driven portable drills, deck planers, etc., will devote especial attention to the production of Dallett pneumatic tools. Their works are equipped with the latest and most improved machinery, and the extensions projected are necessary to enable them to supply the demand for the Dallett tools, which have by their intrinsic merit gained an enviable reputation.

Mr. Henry Engels, located at No. 91 Fremont St., San Francisco, who represents the Chicago Pneumatic Tool Company on the Pacific Coast, has lately secured several large orders for pneumatic equipment, including a number of Franklin air compressors.

With the knowledge of what America has to offer the summer tourist and the rest and health-seeker, the thousands of summer travelers who spend their vacation in "The Highlands of Ontario," unhesitatingly pronounce the Muskoka Lakes region the ideal, the perfectly satisfying summer resort. Such an ideal is a combination of two features—primeval nature in a perfect bewilderment of beauty, charm and variety, and the modern necessaries and conveniences. Handsomely illustrated publications describing this region will be sent free on application to Mr. F. P. Dwyer, Eastern Passenger Agent of the Grand Trunk Railway System, 290 Broadway, New York.

—The Pennsylvania Railroad Company is equipping more of its offices with Nernst lamps, thereby attesting to the superiority of the illumination afforded by this now famous lamp. The Philadelphia office of the Nernst Lamp Company reports that twenty-six six-glower and five three-glower Nernst lamps have recently been installed in the freight department of the Pennsylvania Railroad at Broad and Washington Avenues, Philadelphia, this being one of the most important departments of the company. Several three-glower Nernst lamps have also been placed in the power house at Camden, N. J., and the lighting equipment at the new passenger station is about to be completed by the installation of twenty-three lamps of the three-glower type, which will be an addition to the six-glower Nernst lamps already in use. It is expected that the new shops of the Philadelphia, Baltimore and Washington branch of the Pennsylvania Railroad will be largely lighted by this illuminant, the six-glower type being used.

The Ball Engine Company, Erie, Pa., report shipments of engines for electric service during July to the following: Longmont Beet Sugar Co., Longmont, Colo.; Lookout Mountain Iron Co., Battelle, Ala.; Hamilton Hotel, Louisville, Ky.; Vermont Hospital for Insane, Waterbury, Vt.; Polyclinic Hospital, Philadelphia, Pa.; Tawas Sugar Co., East Tawas, Mich.; Alvoy & Ferguson Co., Louisville, Ky.; Owosso Sugar Co., Owosso, Mich.; Imperial Tobacco Co., Rocky Mount, N. C.; Imperial Tobacco Co., Wilson, N. C.; Pittsburg Coal Co., Alliston Mine; Federal Chemical Co., Nashville, Tenn.; Washington Elec. Light & Power Co., Washington, Pa.; Jefferson Coal Co., Piney Fork, Ohio; Manhattan Railway Co., New York, and others.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Boiler-Tube Cleaner.

Booklet, with illustrations and description of the "Torpedo" cleaner for tubes of return tubular boilers, which consists, essentially, of a rapidly oscillating knocker, moved along the inside of the fire tubes. Also, illustrated description of the "Demon" rotary, water-driven cleaner for water-tube boilers. 6¼ by 3½ in.; pp. 12. The General Specialty Company, Buffalo.

Compressed-Air Pumping.

Catalogue "G," giving a well illustrated and comprehensive description of systems of pumping by compressed air, including the air-lift pump and displacement pumps using air expansively, or using direct pressure of air without expansion, with views of plants in operation. 9 by 6 in.; pp. 47. Pneumatic Engineering Co., 128 Broadway, New York.

Conveying Appliances.

Catalogue No. 7, bound in flexible cloth, with illustrations, descriptions and prices of all kinds of elevating and conveying machinery and other labor-saving appliances for foundries and the coal and iron and steel industries; and also useful tables and data. 7¼ by 9¼ in.; pp. 176. Heyl & Patterson, Pittsburg.

Cranes.

Catalogue, with illustrations and descriptions of revolving pneumatic cranes, portable and stationary; hand-power jib cranes; electric locomotive revolving cranes; standard pneumatic car jacks; portable pneumatic painting machines; and other kinds of cranes and pneumatic apparatus. 5 by 7 in.; pp. 31. The Garry Iron and Steel Company, Cleveland.

Electric Motors.

Bulletin No. 136, with illustrations and descriptions of three types of S. K. C. induction motors, designed for various frequencies and potentials, and adapted to many kinds of service; also, with tables of dimensions. 10½ by 8 in.; pp. 12. Stanley Electric Manufacturing Co., Pittsfield, Mass.

Elevators.

Catalogue, with well-illustrated descriptions of elevating devices of many types, including electric, hydraulic, steam and belt-driven elevators for passengers and freight, escalators, or moving staircases, and incline railways. 9 by 8 in.; pp. 62. Otis Elevator Company, New York.

Feed-Water Purifiers.

Catalogue, with descriptions and illustrations of live-steam feed-water purifiers, exhaust-steam feed-water heaters, steam separators, oil eliminators and exhaust heads, and examples of their operation. 6 by 9 in.; pp. 40. Also, booklet, devoted to steam separators, oil eliminators and exhaust heads. 6 by 4½ in.; pp. 20. The Hoppes Mfg. Co., Springfield, Ohio.

Filing Machine.

Booklet, with illustrated description of the "Kinseyburt" filing machine for all kinds of metals, and directions for setting up and using it. A hack-saw can also be used with the machine. 6 by 3½ in.; pp. 15. Kinsey-Burt Co., 136 Liberty St., New York.

Fire Hose.

Pamphlet, with descriptions and half-tone illustrations of various styles of rubber-lined, seamless, cotton fire hose, views of the processes of its manufacture and history of the evolution of fire hose. 6¾ by 5¼ in.; pp. 48. Eureka Fire Hose Company, New York.

Grinding Machinery.

Catalogue for 1903, with descriptions and illustrations of many styles of the "Challenge" emery grinding and polishing machines, their parts and accessories, which possess many important advantages. 9¼ by 6 in.; pp. 52. Challenge Machine Co., Philadelphia.

Lathes.

Pamphlet, with half-tone illustrations, giving a full description of new bench lathes and attachments, and descriptions of recent improvements in toolmakers' lathes and engine lathes. 9 by 6 in.; pp. 67. Pratt & Whitney Co., Hartford, Conn.

Marine Hardware.

Catalogue, with illustrations, descriptions and prices of blocks, lanterns, cordage, compasses, logs, and all kinds of ship chandlery, yacht supplies and marine hardware. 9¼ by 5¾ in.; pp. 392. Chas. D. Durkee & Co., 3 and 5 South St., New York.

Oil Cups.

Folder, with illustrations and descriptions of the Tucker oil-hole covers and cups, self-closing oilers and other styles of lubricating apparatus. 6¼ by 3½ in.; pp. 4. W. W. & C. F. Tucker, Hartford, Conn.

Pencils.

Illustrated pamphlet, with conveniently arranged descriptions of pencils for every variety of service and all kinds of people, and an interesting account of the making of pencils. 8 by 5 in.; pp. 32. Also, booklet devoted to Dixon's "Eterno," the indelible pencil. 3½ by 6¼ in.; pp. 8. Joseph Dixon Crucible Company, Jersey City, N. J.

Reinforced Concrete.

Bulletin No. 20, with illustrations and description of reinforced concrete construction, and, particularly of the new paper will of the W. D. Boyce Co., Marseilles, Ill., which is built entirely of concrete and steel. 10¾ by 8 in.; pp. 4. Ambursen & Sayles, Watertown, N. Y., and Walter I. Brock, Chicago.

Respirator.

Folder, illustrating and describing the Barnum respirator, by means of which fresh air is supplied to persons working in any confined space filled with gas or foul air. 9½ by 6 in.; pp. 4. P. L. Rider, Worcester, Mass.

Rock Drills.

Catalogue No. 43, the first of a new series being issued by the Ingersoll-Sergeant Drill Co. This pamphlet has handsome half-tone illustrations and elaborate descriptions of rock drills, stone-channeling machines, quarry bars, gadders, coal cutters and other mining and quarrying machinery, and many views of their practical application in all parts of the world. 9 by 6 in.; pp. 167. Ingersoll-Sergeant Drill Co., New York.

Catalogue No. 51, with descriptions and handsome half-tone and tinted illustrations of rock drills, stone-channeling machines and other rock excavating machinery, and examples of their use. 9 by 6 in.; pp. 11. Also, catalogue No. 52, devoted to rock drills and air compressors. 9 by 6 in.; pp. 110. Sullivan Machinery Co., Chicago.

Roller Bearings.

Catalogue, with descriptions and illustrations of roller bearings for power transmission and general mill purposes, and of bearing boxes, hangers, pillow blocks and other shafting appliances. 6 by 9 in.; pp. 23. American Roller Bearing Co., Boston.

Roofing.

"A Ruberoid Album," a pamphlet devoted to the merits of Ruberoid roofing, which is waterproof, acid-proof and fire-resisting, and containing views of a great variety of buildings in all parts of the world, which are covered with this roofing. 9 by 6 in.; pp. 48. The Standard Paint Company, New York.

Steam Engines.

Catalogue, with illustrations and descriptions of the well known Reynolds-Corliss steam engines, with views of the Allis works, where they are made, and of plants in many parts of the world where they are in operation. Among the engines shown are ones for street railways, electric lighting, pumping, blowing, rolling mills, hoisting and all kinds of power purposes, as well as air compressors. 6¾ by 9¼ in.; pp. 177. Allis-Chalmers Company, Chicago.

Pamphlet, with illustrations and descriptions of direct-connected automatic cut-off steam engines of the enclosed type, built in accordance with the recent recommendations made by the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. 6 by 9 in.; pp. 6. Chandler & Taylor Co., Indianapolis.

Stokers.

Large catalogue, containing a comprehensive description of the Jones under-feed mechanical stoker and its operation, illustrated by half-tones and line engravings, and views of many steam-boiler plants where it is installed. 12 by 9 in.; pp. 48. The Under-Feed Stoker Co. of America, Chicago.

Strainer.

Booklet, illustrating and describing the King deep well strainer, made of hardened wire wound on longitudinal ribs of hard-rolled metal, for letting down inside the well casings. 6 by 3½ in.; pp. 6. The Kisinger-Ison Co., Cincinnati.

Smelting.

Illustrated pamphlet, giving a great deal of useful and up-to-date information about smelting practice and equipment for the reduction of gold, silver, lead and copper ores. 9¾ by 6¾ in.; pp. 134. The Colorado Iron Works Co., Denver.

Tempering.

Booklet telling about the hardening and tempering of steel, and of facilities and up-to-date equipment for performing such work. 5¾ by 3½ in.; pp. 7. The Bennett Tempering Co., New Britain, Conn.

Turbine Pumps.

Bulletin—Series T, No. 5, devoted to steam and electric turbine pumps, with illustrations and descriptions of De Laval steam turbines and turbine pumps direct connected. 10 by 7 in.; pp. 8. D'Olier Engineering Co., Philadelphia.

Water Wheels.

A pamphlet containing a copyrighted paper by Geo. J. Henry, Jr., entitled, "Tangential Water Wheel Efficiencies," being an experimental investigation of the relative values of different bucket shapes, with numerous illustrations, read before the Pacific Coast Electric Transmission Association. 9¼ by 6 in.; pp. 43. The Pelton Water Wheel Co., San Francisco, Cal.

Wood Pavements.

Cloth-bound book, entitled "Creo-Resinate Wood Pavements for Streets and Bridges," by F. A. Kummer, C. E., containing descriptions and illustrations of successful wood pavements in many cities, and specifications for bridge pavement. 7¾ by 5½ in.; pp. 42. Also, pamphlet with views of creo-resinate wood pavements and testimonials. 7½ by 5¼ in.; pp. 25. United States Wood Preserving Co., 29 Broadway, New York.

Wood Pipe.

Catalogue No. 2, entitled "The Whole Story About Wood Pipe," with illustrations and descriptions of Woodward patent machine-banded wood water pipe, and Wheeler patent continuous stave pipe, and much information about wood pipe in general, including tables for flow of water through it. 7¾ by 5 in.; pp. 84. National Wood Pipe Co., Los Angeles and San Francisco, California.